G-R-S NEWS

VOLUME 2

GENERAL RAILWAY SIGNAL COMPANY
ROCHESTER, N. Y

ALBERT C. SMITH

G-R-S NEWS
January 1946

Fundamentals of Carrier Systems

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The next topic to be discussed is the carrier-telephone systems in use today in the United States and Canada.

II. The Carrier Telephone Systems of Today

Of all the services that cTc Carrier-link Control may be combined with, the telephone systems are the most common. cTc carrier can be combined more readily with voice-frequency telephone systems than with carrier-frequency telephone systems. The reasons for this will be clearer as we enlarge our understanding of carrier-telephone systems.

A. Before Carrier Telephone

Let us go back in history for awhile to telephony before carrier, to enable us to see what led up to the development of carrier telephony and what had been accomplished.

Telephonic transmission of speech requires three fundamental elements:

1. A transmitter which, when acted upon by the acoustic waves of the speaker's voice, produces, in an electric circuit, oscillations or waves suitable to represent the voice of the speaker.
2. A circuit from the point of transmission to the point of reception. This circuit (open-wire lines or wires in cable) must be suitable to transmit the complicated

junction of the two sections, the voltages in the two sections of the same wire can be made to cancel one another out. The effect of this transposition is to neutralize induction over the entire length of the line so that there is hardly any noticeable effect at the circuit terminals.

Transposition systems have been developed and have become very complex with the multiplication of circuits on pole lines and the inductive effects being experienced from paralleling power lines.

Another interesting development was the "phantom circuit" which started as a theoretical concept of a man named Jacob. In 1883 he conceived the idea that by bridging resistances across each end of two parallel telephone circuits, a third circuit could be created (without the addition of line wires) by connecting telephones at each end between the mid-point of these resistors. Figure 2 shows this idea.

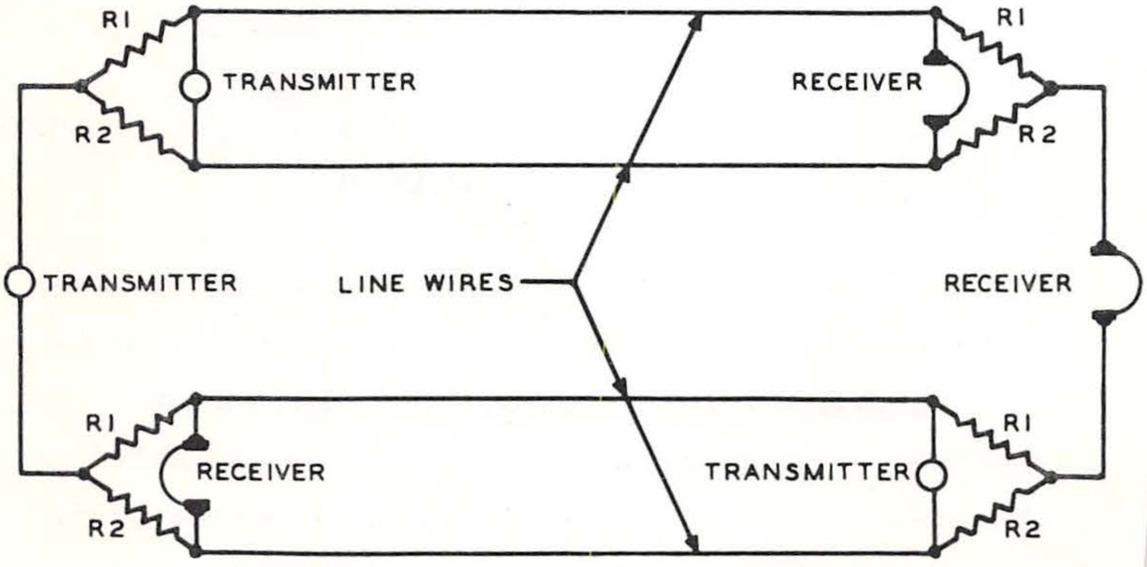

Figure 2. The phantom circuit of F. Jacob. Resistors R1 and R2 are equal.

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electrical oscillations in the proper magnitude without undue distortion of form and without interference from electrical currents from other sources (known as "noise", "cross-talk").

3. A receiver which, when receiving the electrical oscillations transmitted over the circuit, reproduces acoustic waves of the proper loudness and quality to correspond with those produced by the speaker's voice.

The story of how Elisha Graham Bell in 1875 succeeded in devising instruments and a circuit to transmit voice over wire is well-known. Since that time many improvements were made both in the United States and abroad. The granular carbon transmitter, telephone switching systems, toll connections, hardened copper line wire in place of iron wire, underground cables of the lead jacketed type, paper insulation for cable wires - - - these and other developments filled the early records of the Bell System and influenced to a large degree the art of electrical transmission and communication.

Up to 1883 telephone practice was influenced by telegraph practice in that one wire was "grounded" at both ends to give a "ground return circuit" and only one line wire was therefore required, thus saving on the cost of the line. This was satisfactory on short circuits, but as circuits were installed over long distances it was found that the ground return circuit was so noisy, because of interference from telegraph lines and other causes, that it became practically useless. So the ground circuit was eliminated and two wires were used with success, making it possible to install longer telephone circuits.

One of the important contributions to the successful transmission of electrical voice-frequency waves was "transposition" of wires in the line circuit. Around 1885 it was found that with two or more metallic circuits on a pole line, voice-frequency currents flowing in one circuit caused similar, weaker currents to flow in the other circuits. This induction came to be known as "cross-talk". On long lines it was so pronounced that one could overhear on one circuit what was said on another.

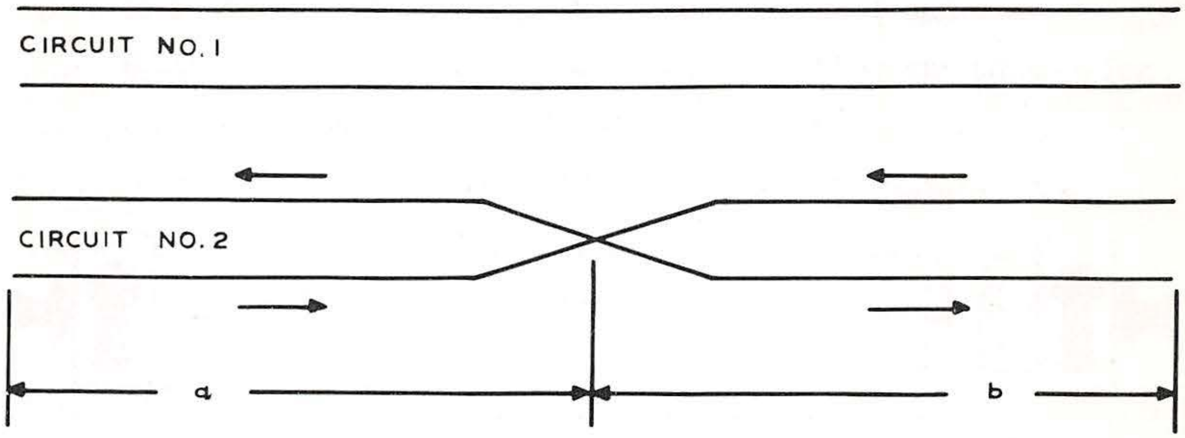

Figure 1. Circuit transposition showing how induced voltages are caused to oppose one another, thus canceling out.

To neutralize this inductive effect the positions of the wires of a circuit were interchanged. For example, in Figure 1, the simple case of two circuits is shown. The circuit sections "a" and "b" are equal in length, and voltages are being induced into circuit No. 2 from circuit No. 1. The arrows show the directions in which the induced current would tend to flow in circuit No. 2, the wires of which are interchanged as to position, between the two sections. The induced voltage in section "b" is equal in magnitude to that in section "a". By interchanging the wires at the junction of the two sections, the voltages in the two sections of the same wire can be made to cancel one another out. The effect of this transposition is to neutralize induction over the entire length of the line so that there is hardly any noticeable effect at the circuit terminals.

Transposition systems have been developed and have become very complex with the multiplication of circuits on pole lines and the inductive effects being experienced from paralleling power lines.

Another interesting development was the "phantom circuit" which started as a theoretical concept of a man named Jacob. In 1883 he conceived the idea that by bridging resistances across each end of two parallel telephone circuits, a third circuit could be created (without the addition of line wires) by connecting telephones at each end between the mid-point of these resistors. Figure 2 shows this idea.

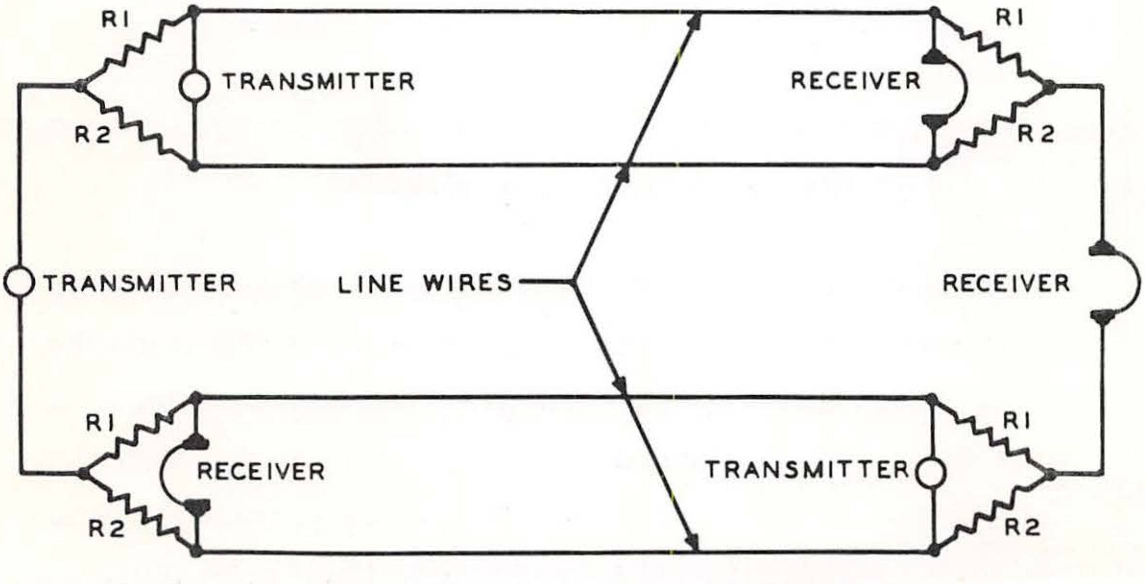

Figure 2. The phantom circuit of F. Jacob. Resistors R1 and R2 are equal.

This idea was not practical, but had possibilities. In 1886 Carty proposed using balanced transformers, and developed the circuit shown in Figure 3. The difficulty he had to overcome was that of perfect balance in the transformer windings so that the current from the phantom circuit would divide equally between the two halves of the windings and not influence the "side" circuits. After a great deal of careful experimentation and painstaking work phantom circuits were operating successfully in 1903. By 1936, 12,400,000 miles of wire were installed in such a way as to be suitable for phantom operation. Without phantoming 6,200,000 additional miles of wire would have been required for the same circuit mileage.

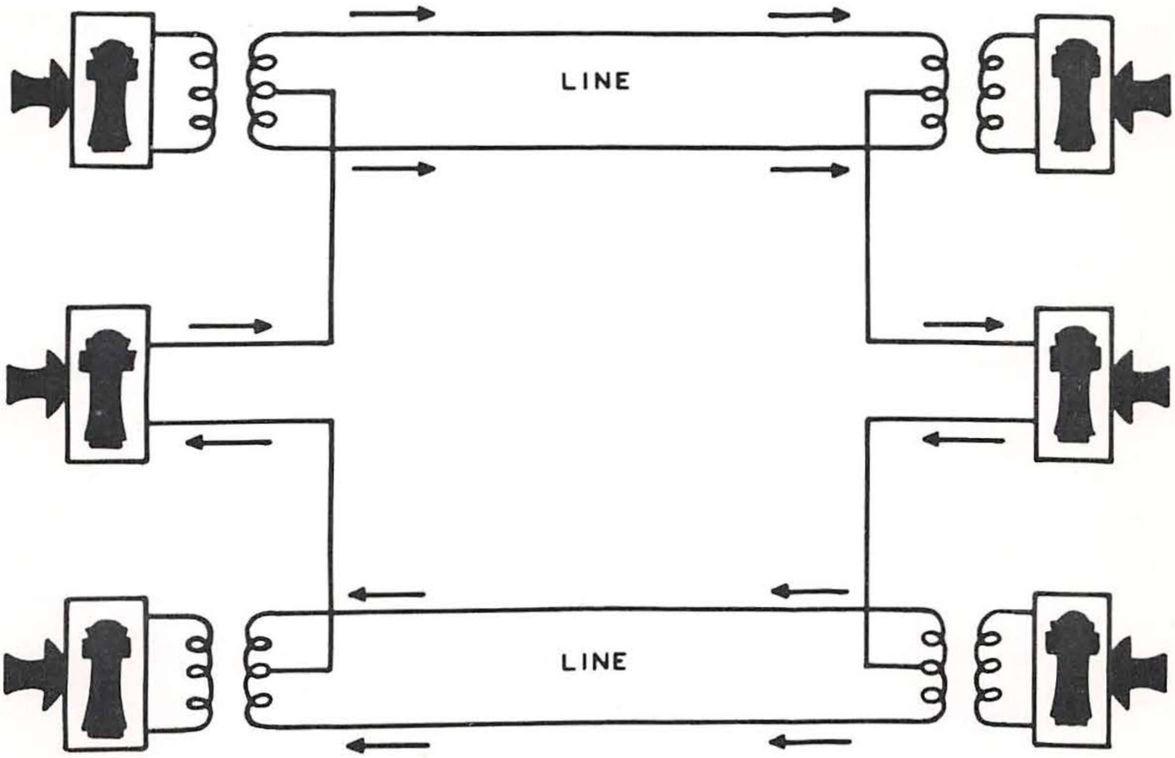

Figure 3. Phantom circuit using Carty's balanced transformers or "repeating coils". Arrows show path of phantom current.

An adaptation of the phantom principle led to the practical transmission of telegraph on telephone circuits. The first method, called "simplexing", introduced the telegraph circuit at the midpoint of the repeating coils at the two ends of the telephone circuit. This is illustrated in Figure 4.

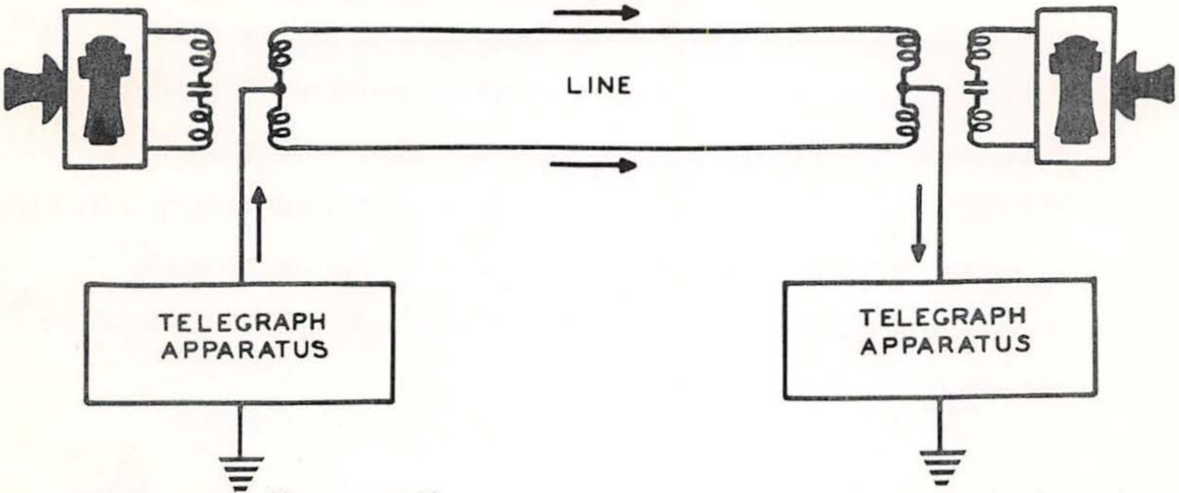

Figure 4. The "simplex" method of superimposing a telegraph circuit on a telephone circuit.

For intelligible voice transmission it was found that the telephone apparatus and circuits should be capable of operating over a range of frequencies from 250 up to 2,750 cycles per second. It was also found that successful telegraphic transmission could be handled on the range of frequencies from zero up to about 100 cycles. These facts led to the principle of separating the electrical currents due to voice and those due to telegraph into different "channels". Apparatus known as "composite sets" was developed for the two ends of the line and the telegraph and telephone currents were kept separate at the terminals even though they were transmitted on the same pair of line wires. Figure 5 shows a schematic diagram of the superposition of telegraph circuits on telephone using composite sets.

All the aforementioned developments were paving the way for carrier operation which first came into commercial use in 1918.

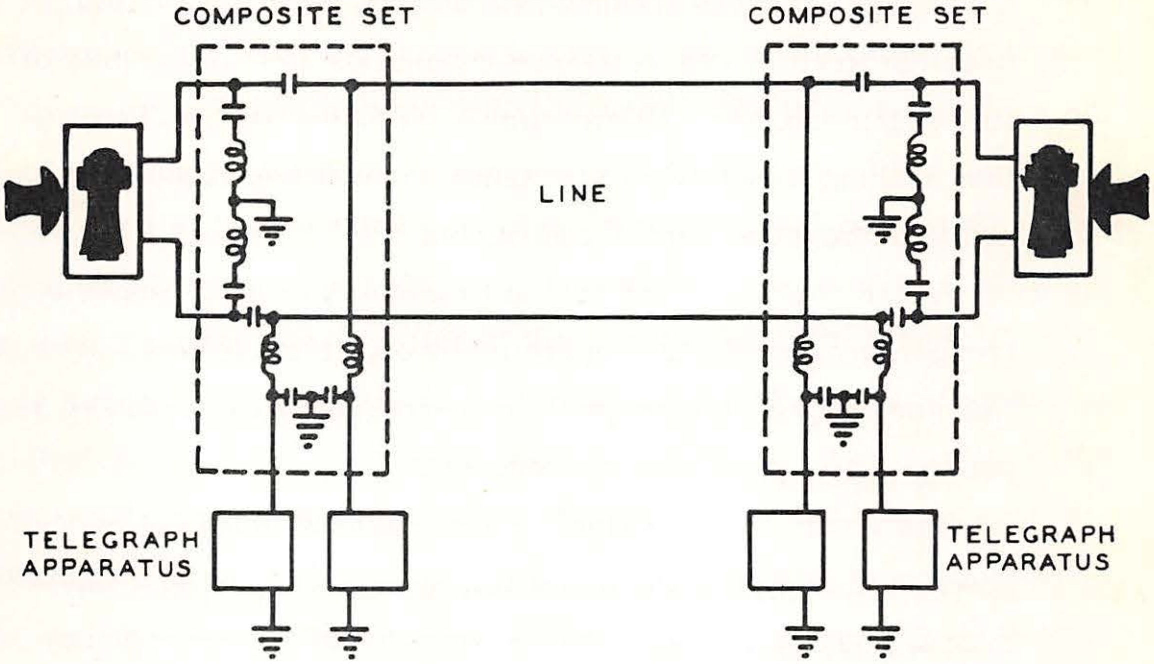
COMPOSITE SET
COMPOSITE SET
LINE
TELEGRAPH APPARATUS
TELEGRAPH APPARATUS

Figure 5. Telegraph circuits superposed on telephone using composite sets.

B. Carrier Telephone

The development of carrier telephony was made possible by three important contributions to the art:

1. The development of vacuum tubes as amplifiers, modulalators, and demodulators;
2. The improvement of electrical filters for passing or choking back currents on the basis of differences in their frequency;
3. The improvement in the technique of transmitting over long circuits without interference.

In carrier operation voice-frequency currents "modulate" a high-frequency "carrier" current, so called because it serves as a "carrier" for the message. By using a carrier frequency well above the voice frequencies, that is, above 2750 c.p.s., it is possible to add a new telephone channel on an existing pair of line wires. In fact, several carrier frequencies may be used thus making it possible to transmit several messages simultaneously on the same pair of line wires.

At the receiving terminal the various incoming ranges of high-frequency currents are separated by electrical filters. Then, by "demodulation", the original voice-frequency currents are reproduced and applied to the receivers.

The term "multiplexing" is used in describing the superimposition of all these additional telephone facilities on a line which may already be carrying d-c. telegraph and voice-frequency telephone. *

* * *

The details of the various carrier telephone systems will be described in a coming issue. For those desiring more detailed information on what has already been presented, the following references are recommended for further study:

Albert, Arthur L. Electrical Communication. John Wiley and Sons.

Gherardi, B. and Jewett, F. B. Telephone Communication System of the United States. Bell System Technical Journal, January, 1930.

Technical Developments Underlying the Toll Services of the Bell System. Supplement to the Bell System Technical Journal, July, 1936.

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* The term "multiplexing" is also used to describe the simultaneous transmission of two or more messages in either or both directions over the same transmission path

Care of Commutators and Brushes in Switch Machine Motors

Questions are raised from time to time regarding the recommended procedure for proper maintenance of commutators and brushes in switch machine motors. The following directions, which are included in Handbook 24 on switch machines, are repeated here for your information and ready reference.

Commutators should be kept clean by rubbing with a lint-free cloth or preferable, a small chamois skin moistened with a light lubricating oil. This should be followed by wiping with a dry cloth or chamois. After the motors have been in service for a time, the commutators should become brown or coffee-colored, and highly polished.

Any accumulation of carbon dust around the commutator end of the armature, in the brush holder or on the sides of the brushes should be removed.

A brush removed from its holder should be replaced in the same holder in the same position it was before removal.

Brushes should slide freely in the holders and seat fully on the commutator.

If brush does not seat fully on the commutator, it should be ground in by placing a strip of No. 00 finishing flint or garnet paper under the brush and around the commutator with the abrasive side to the brush and, while holding the paper firmly to the commutator, rocking the armature back and forth until the brush seats properly.

For the 45630-14 motor, the paper may be cut and fitted with a handle as shown in Figure 6. First remove the brush being fitted; then insert the paper rough side up as shown and replace the brush. While moving the paper back and forth under the brush, keep the paper shaped to the contour of the commutator as much as possible.

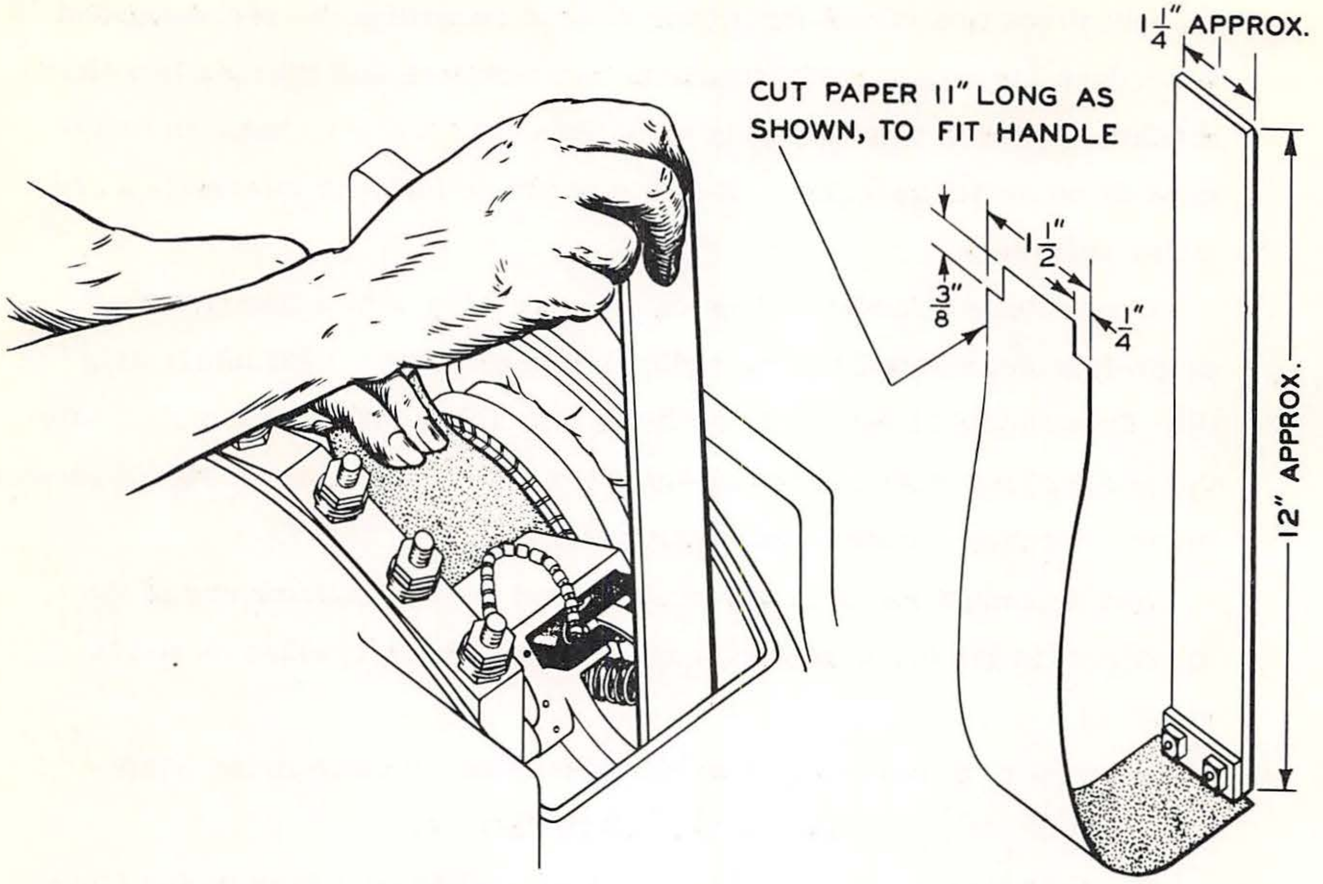

$1\frac{1}{4}$" APPROX.
CUT PAPER 11" LONG AS SHOWN, TO FIT HANDLE
$1\frac{1}{2}$"
$\frac{3}{8}$"
$\frac{1}{4}$"
12" APPROX.

Figure 6. Method of grinding in brushes on 45630-14 motors.

When installing new brushes, use No. 1 paper for roughing and finish with No. 00.

If the commutator shows evidence of pitting, the cause should be determined and remedied (high micas, high dynamic-indication current, etc.). Should it become necessary to redress the commutator, the armature should be removed and the commutator turned down in a lathe, using a sharp diamond-point tool with a high speed and a slow feed.

After being turned down, the micas should be undercut and the commutator then ground or polished with No. 7-0 garnet paper. Brushes should be refitted to commutator as described above.

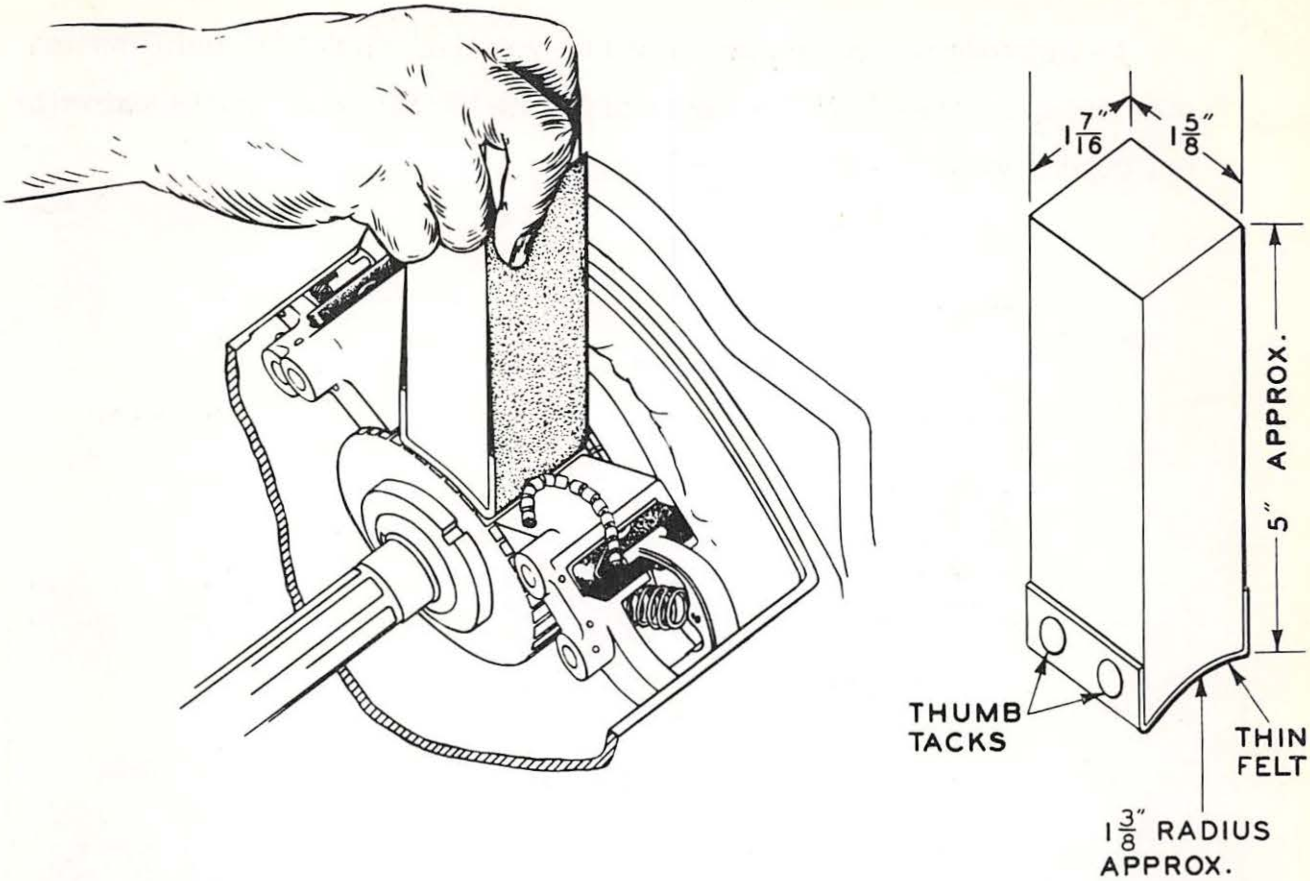


Figure 7. Polishing commutator with flint paper applied with a felt-tipped block.

If the commutator of a 45630-14 motor is not too rough and only needs cleaning and polishing, this can be done with a strip of flint or garnet paper cut and fitted to a felt-tipped wooden block as shown in Figure 7. Use No. 00 paper first and finish with No. 7-0.

Release brake by inserting a 1/2-inch block under the brake solenoid plunger. Hold the sanding block against the commutator as shown and crank the machine first in one direction and then in the other until the desired finish is obtained.

Note: As stated previously, after motors have been in service for a time, the commutators should become brown or coffee-colored, and highly polished. This is their normal appearance. Do not sand such commutators.

To improve the commutation of 110-volt d-c. Model 5C and D switch machines, brushes 35780-9 L.H. and 35780-10 R.H. with shunts and without copper wire insert are now used.

* * *

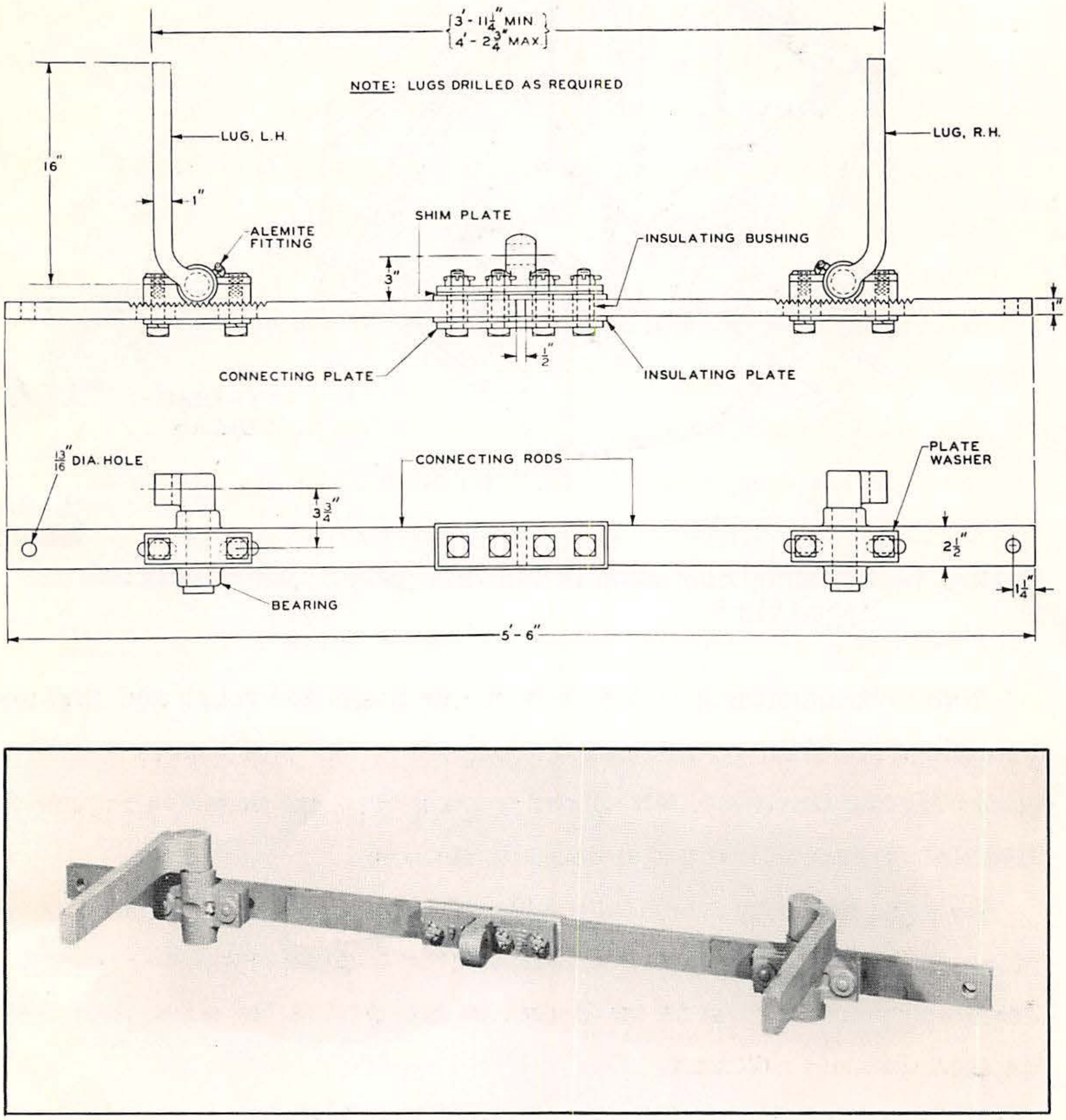

3'-11 1/4" MIN
4'-2 3/4" MAX
NOTE: LUGS DRILLED AS REQUIRED
LUG, L.H.
LUG, R.H.
16"
1"
ALEMITE FITTING
SHIM PLATE
INSULATING BUSHING
3"
1"
1/2"
CONNECTING PLATE
INSULATING PLATE
13/16" DIA. HOLE
CONNECTING RODS
PLATE WASHER
3 3/4"
2 1/2"
1 1/4"
BEARING
5'-6"

Figure 8. Hinged front rod.

Hinged Front Rod

A new hinged front rod (22870-133) has been designed to provide a free-moving switch on turnouts of any size, at the same time supplying the rigidity required to prevent switch point roll.

As shown in Figure 8, the unit comprises a connecting rod assembly, two bearings, and two switch point lugs. The connecting rod unit is made up of two heavy bars (2-1/2 in. by 1 in.) fastened end-to-end by suitably insulated connecting plates. The bearings are split type, bolted to the connecting rod, provision being made for adjustment of between-center spacing. Switch lugs carry integral hinge pins which operate vertically in the bearing assemblies. Lugs are furnished blank as illustrated, or drilled or slotted for lug bolts.

The arrangement described permits free horizontal movement of switch points by reason of the pivoting action of the lugs in the bearings, but prevents point roll because of the rigidity of the linkage with respect to such motion.

Bearings are lubricated through standard high-pressure fittings. This feature, in combination with 5-inch bearing contact length makes for long bearing life. Bearings worn in service may be reconditioned by separating halves, machining or grinding sufficient stock from mating flats, reassembly, then boring and reaming to size.

Center lugs of various types are available for connection of lock rods to the hinged front rod. This same type of rod, by using suitable adjusting brackets, may be used as a No. 1 rod.

* * *

Biographies of the Month

This issue features the biographies of Messrs. Black, Cullen, Dunn, Swanson, Troth, and Walters, who celebrate their birthdays this month.

Harry Lee Black, signal engineer of the Atlantic Region, Canadian National, with headquarters at Moncton, N.B., was born January 20, 1890 in Milford, Ill. He entered railway service in 1906 as a wireman on the Union Pacific. In 1907 he served as maintainer on the Chicago & Eastern Illinois and, later that year, he did construction work for the Southern Pacific. He returned to the Chicago & Eastern Illinois in 1908 as a maintainer. In 1909 he went with Chicago, Rock Island & Pacific as a wireman and foreman, returning again to the Chicago & Eastern Illinois in 1911 as a signal foreman. Mr. Black went with the Hall Switch & Signal Company as a construction foreman in 1912, and with the Union Switch & Signal Company in the same capacity in 1914. In 1915, Mr. Black returned to the Rock Island as a signal foreman, serving in this capacity until 1916 when he went with the Canadian Government Railway as a signal foreman. In 1918 he went with the Grand Trunk serving as a supervisor until 1923, when he was appointed superintendent of signals on the Central Region of the Canadian National. He continued in this capacity until March, 1944, when he was appointed signal engineer of the Atlantic Region.

Ronald J. Cullen, signal engineer, Boston and Albany, with headquarters at Boston, Mass. was born January 20, 1891 in Pittsfield, Mass. After completing a course in the Springfield Technical high school, he first entered railway service on September 3, 1910, as a helper in the signal department of the Boston & Albany, at Springfield, Mass. In January, 1915, he was promoted to assistant maintainer and in March of the following year was promoted to signal draftsman in the office of the signal engineer at Boston, holding this position until December, 1924, when he was appointed assistant engineer, signal department, which position he held until his promotion to signal engineer and superintendent of telegraph, January 1, 1927.

Homer W. Dunn, signal engineer, Western Pacific, with headquarters at San Francisco, California, was born January 29, 1892, near Delta, Iowa. During the summer months of 1913, he was employed on signal construction work for the Union Switch & Signal Company on the Chicago, Milwaukee, St. Paul & Pacific. In June, 1914, after graduating from the University of Arkansas with a B.E.E. degree, he was accepted for an apprenticeship course in the engineering department of the U.S. & S. Co. at Swissvale, Pa., serving part of his time in signal construction on the Western Maryland. In 1916, Mr. Dunn accepted a position as draftsman in the signal engineer's office of the Coast Lines of the Santa Fe at Los Angeles. In April, 1923, he was promoted to chief draftsman, and in September, 1939, he was advanced to assistant signal engineer, the position he held at the time of his appointment on the Western Pacific in June, 1944.

Louis A. Swanson, assistant signal engineer, Interborough Rapid Transit Company, New York City, was born January 26, 1904 in Latrobe, Pa. He attended the public schools in Latrobe and was graduated from Pennsylvania State College in 1925 with a degree of B.S. in electrical engineering. After working a short time with the Westinghouse Electric & Manufacturing Company, he entered the employ of the Union Switch & Signal Company in 1927 as a signal helper in the construction force. He worked as signalman and foreman in this department until 1931, when he was employed as circuit engineer in the signal department of the Interborough Rapid Transit Company. He was appointed office engineer in October, 1931, and held that position until his appointment as assistant signal engineer in March, 1940.

R. W. Troth, signal engineer, St. Louis - San Francisco, with headquarters at Springfield, Mo. was born January 19, 1900 in Valley Falls, Kansas. Following a public school education, Mr. Troth entered the service of the Santa Fe at Valley Falls as station helper on August 1, 1919. He was appointed operator at Emporia, Kan., on October 1, 1919, and served in this capacity until April 24, 1922, when he entered the signal department as a helper. On August 1, 1923, Mr. Troth entered the office of the signal engineer, Eastern Lines, as draftsman and served as draftsman, signalman on construction, and supervisor of materials until June 15, 1927, when he resigned to enter the signal department of the St. Louis - San Francisco as draftsman. He was promoted to chief draftsman in March, 1928, to office engineer in April,1929, and to signal inspector on October 16, 1936. He was appointed signal engineer in August, 1940.

Lewis Clayton Walters, assistant to vice-president, signals and electrical, Southern Railway System, with headquarters at Washington, D.C.,was born January 23, 1891 in Jamaica, N.Y. He received a high school education and later carried on a correspondence course in electrical engineering. Prior to entering the service of the Southern on July 13, 1913, he had had seven years' experience with the General Railway Signal Company as follows: office work, timekeeper, helper, assistant fitter, assistant wireman, wireman, assistant foreman and foreman. From the date mentioned above until the present he has been continuously employed in the signal department of the Southern. His first position was that of signal maintainer and on March 6, 1914, he was promoted to general foreman. In this capacity he served four months, at which time he was appointed assistant signal supervisor. Two years later he was promoted to signal supervisor, and, on December 1, 1918, he was appointed signal and electrical inspector, which position he held until June, 1920, at which time he was promoted to signal and electrical engineer, Lines West, with headquarters at Cincinnati, Ohio. His title was changed to signal and electrical superintendent, Lines West, in 1927, and he held this position until his promotion to assistant to vice-president in August,1941.

G-R-S NEWS
April 1946

Railroad Radio

On February 21, 1946 our William D. Hailes gave a talk on "Railroad Radio" before a joint meeting of the I.R.E., the A.I.E.E., and the Rochester Engineering Society at the Sheraton Hotel in Rochester.

His talk is presented in this issue for your information.

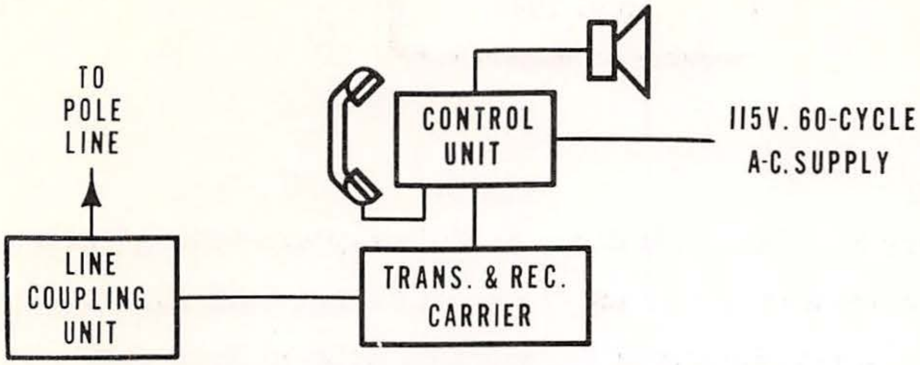
*

I. INTRODUCTION

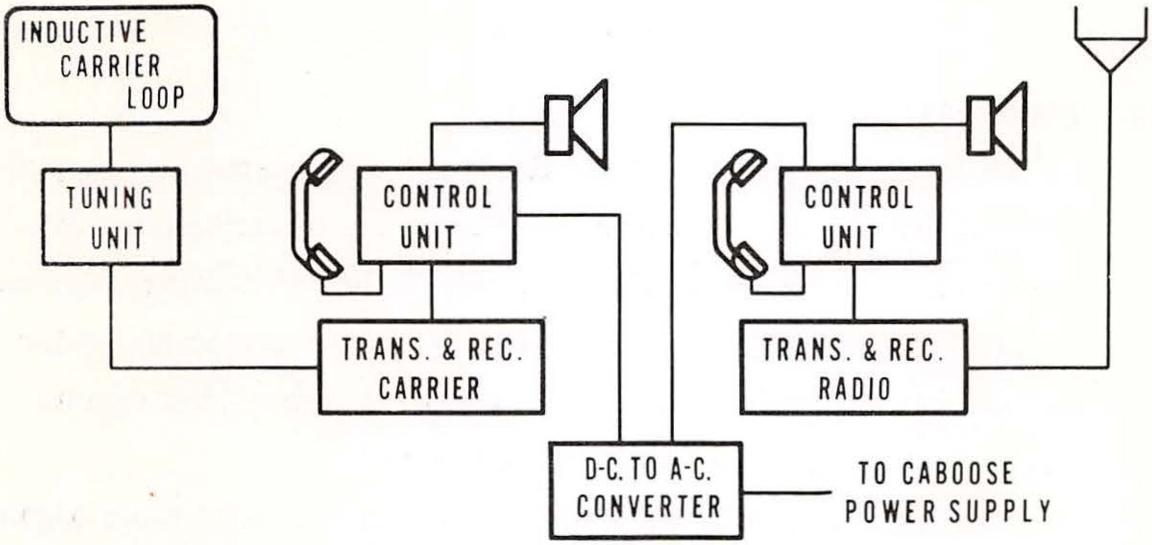
This talk will deal with the subject of radio telephone as applied to the needs of railroad operation. I expect to describe the more important railroad uses for radio phone, to tell something about the kind of equipment that has been developed and is contemplated for use in railroad radio systems and to discuss some of the results that have been obtained on test installations.

The present activity and public interest in railroad radio began in 1944 with a special investigation and hearings by the Federal Communications Commission to determine how much in the way of increased safety and general benefit could be expected from the use of radio telephone in various phases of railroad operation.

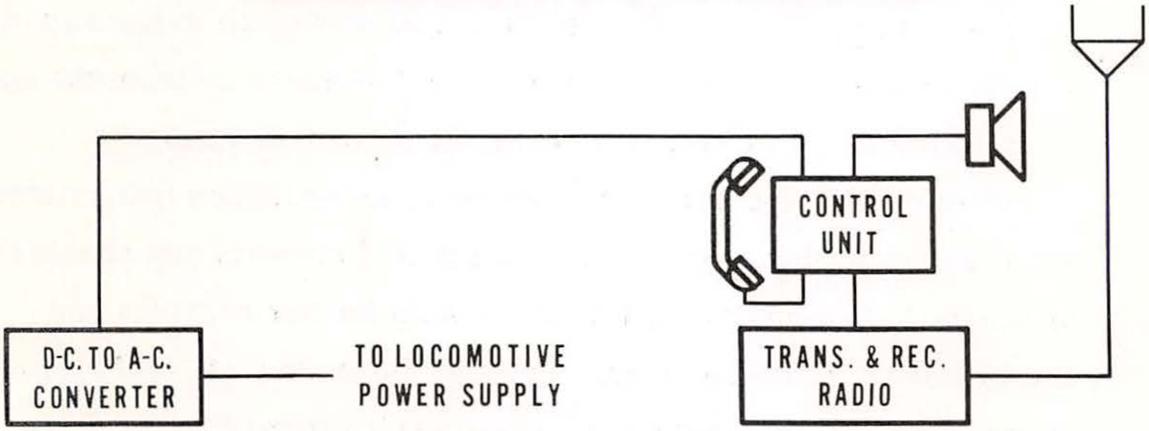
The Commission was convinced by its investigation that railroad radio will contribute to the safety of life and property and should be of benefit to the public. It, therefore, held further hearings and finally issued its recent order, effective December 31, 1945, promulgating the rules and regulations governing a railroad radio service and allocating a sizeable number of frequencies for this service.


TO POLE LINE
CONTROL UNIT
115V. 60-CYCLE A-C. SUPPLY
LINE COUPLING UNIT
TRANS. & REC. CARRIER

INDUCTIVE CARRIER AT WAYSIDE LOCATION


INDUCTIVE CARRIER LOOP
TUNING UNIT
CONTROL UNIT
TRANS. & REC. CARRIER
CONTROL UNIT
TRANS. & REC. RADIO
D-C. TO A-C. CONVERTER
TO CABOOSE POWER SUPPLY

INDUCTIVE CARRIER & RADIO ON CABOOSE


CONTROL UNIT
D-C. TO A-C. CONVERTER
TO LOCOMOTIVE POWER SUPPLY
TRANS. & REC. RADIO

RADIO ON LOCOMOTIVE

Figure 1. Carrier and radio with point-to-train by inductive carrier and end-to-end by radio.

II. WHAT IT IS

A. Definition

Railroad radio has come to mean a train communication system which provides two-way telephone communication between mobile stations on railroad rolling stock, on the same or different trains and from land stations to these mobile stations and between certain land stations of the system. It is used to assist in railroad operation and promote safety.

There are also utility stations for special needs and emergencies when other forms of communication have failed, and a walkie-talkie may ultimately form an important part of a complete system.

The name "railroad radio" is used as a broad descriptive term to include both the space radiation and the inductive carrier methods of communication used in train communication systems.

B. Two Kinds

The difference between these methods is a technical one which is not apparent to the railroad personnel using them. Both space radiation and inductive coupling are made to give the same sort of telephone communication and they are used and controlled in an identical manner, Figure 1.

The inductive carrier method requires the presence of wires along the railway to act as wave guides and to furnish a means with which to couple a remote land station to the mobile stations as they stand or move along the railroad near the wires.

The space radiation method does not use and does not require the presence of wires. It is true radio communication.

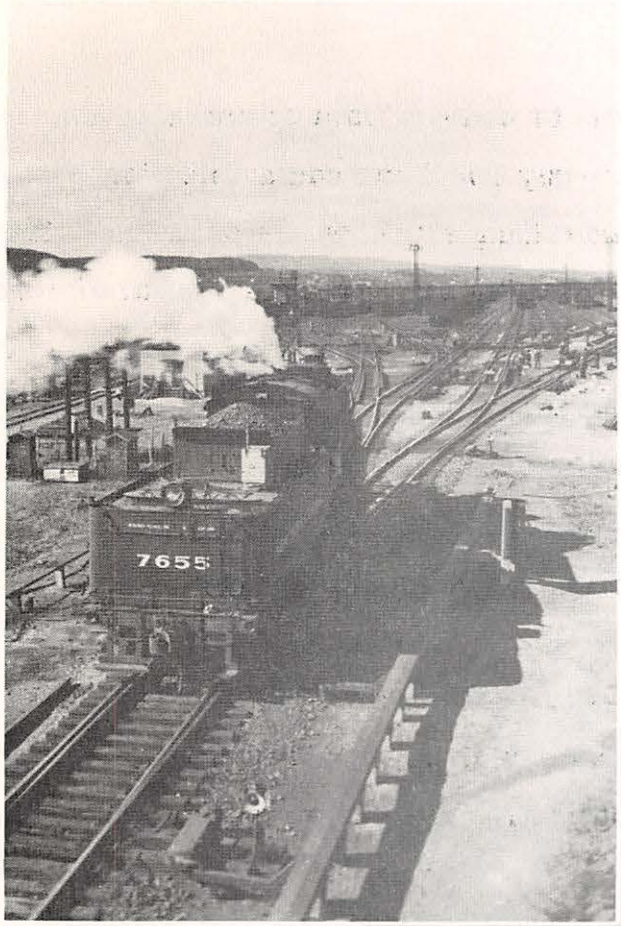
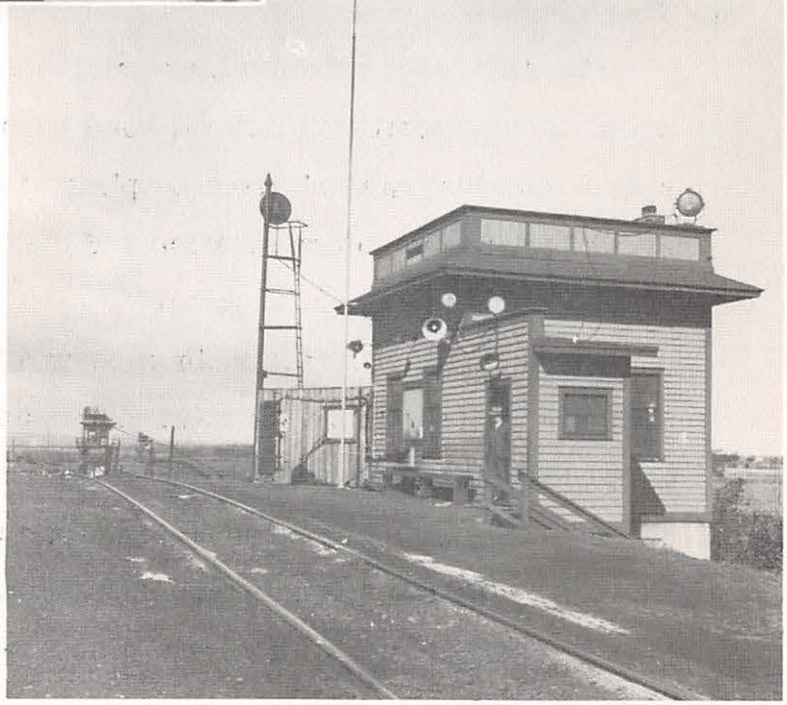


Figure 2. Radio in hump yard operation. Trimmer engine in Selkirk Yard, near Albany. New York Central Lines East.

Figure 3. Hump conductor's office, Selkirk Yard.



C. A Typical Station

A typical station has an equipment cabinet or case in which are housed the transmitter and receiver. It has a speaker, a handset or microphone, a control unit, and an antenna or loop with a coupling unit. The equipment* is usually built to be energized at 117 volts 60 cycles from which all voltages and currents are derived by the power packs of the equipment itself. This facilitates uniformity of electronic equipment. At a land station the 60-cycle energy usually comes from a commercial source of 60-cycle power. On a mobile station it is usually necessary to take energy from a battery or d-c. generator and convert it into 60-cycle energy.

III. HOW IT WILL BE USED

A. Principle Divisions of Operation Where Railroad Radio is Useful

There are three important divisions of railroad operation in which railroad radio has already proved of great help. These are: operation of classification yards, particularly hump yards; operation of terminal areas; and the operation of main line service. Other operations may also use railroad radio to good advantage as more equipment becomes available and railroad personnel has a chance to become familiar with the radio and its possibilities.

B. Yard Operation

Hump yard operation, Figure 2, offers an excellent opportunity for using railroad radio and presents some special requirements that the radio must meet.

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* For illustrations of this equipment see G-R-S NEWS, November, 1945.

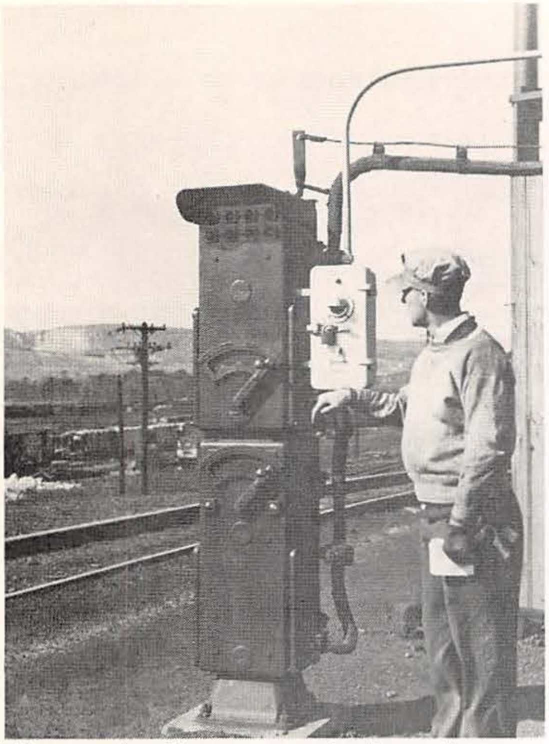


Figure 4. Hump conductor at control unit, Selkirk.

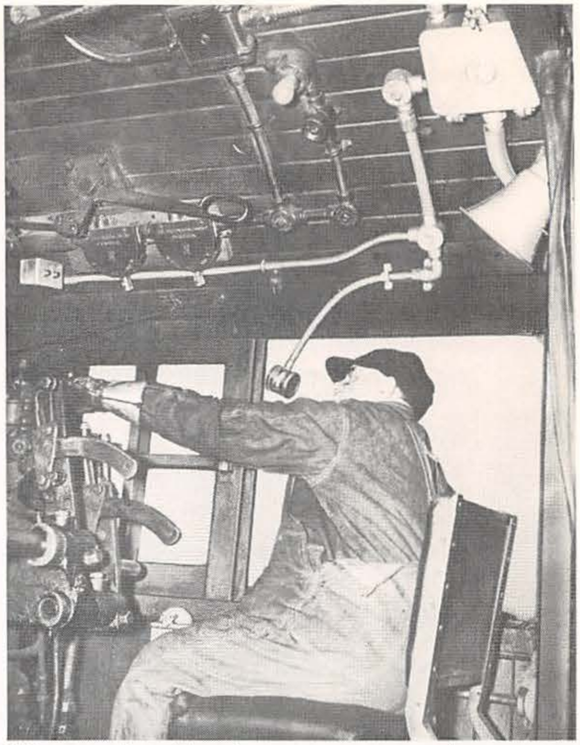


Figure 5. Engineman on pusher using radio.

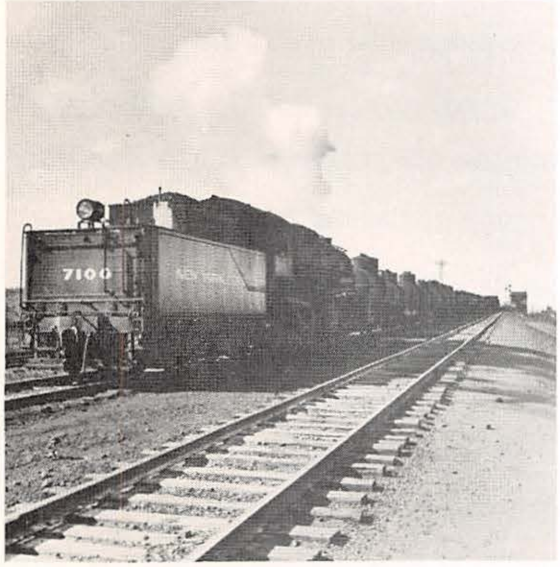


Figure 6. Pusher humping string of oil cars.

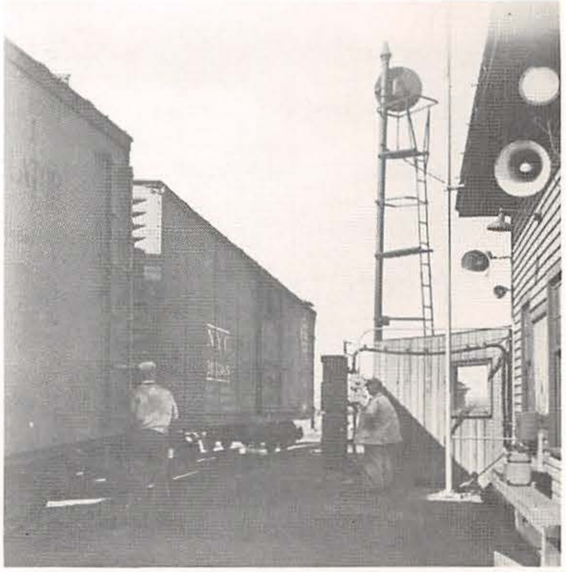
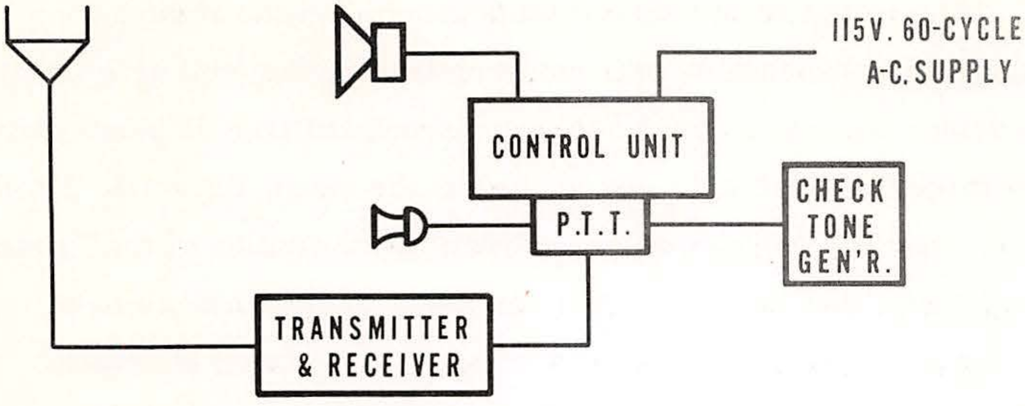


Figure 7. Cutting cars on the crest of the hump.

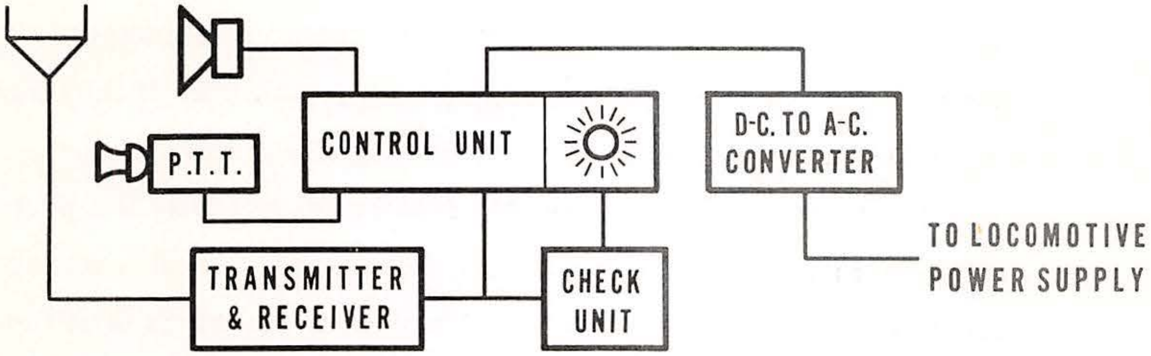
The nature of this operation demands that the radio have a thoroughly dependable self-checking feature that will give instant warning if the system should become inoperative. In hump yard service the fixed station is located at the hump, Figure 3. From this point the hump conductor directs the activities of the "pusher" and "trimmer" engines. Here is where radio plays its role.

The operation of pushing a train over the hump is started with the radio instructions to the pusher engine to get behind the train on track so and so. At this point the pusher engine is probably two miles from the hump, but by means of the two-way radio the hump conductor, Figure 4, and engineman on the pusher engine, Figure 5, are able to cooperate as readily as if they were within speaking distance.

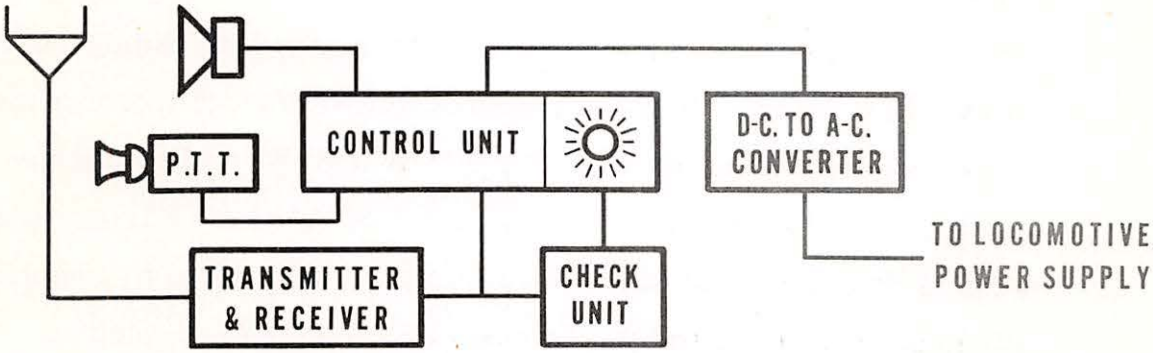
Details are quickly arranged and when all is ready the pusher starts the long "pull", which should be called a "push", up the mile-long hump, Figure 6. When the leading end arrives at the hump, the hump conductor will begin separating the train into "cuts" of one or several cars, each cut bound for a particular clasification track into which it rolls by gravity, Figure 7. It is during these humping and cutting operations that radio does a most effective job. It is not possible to give enough information by signals to enable the hump conductor and the pusher engineman to work to full advantage under all conditions. For example, when a coupler pin sticks, the radio saves much time by enabling the hump conductor to tell the pusher engineman just what is happening at the hump.


115V. 60-CYCLE
A-C. SUPPLY
CONTROL UNIT
P.T.T.
CHECK
TONE
GEN'R.
TRANSMITTER
& RECEIVER

RADIO AT CREST OF HUMP


P.T.T.
CONTROL UNIT
D-C. TO A-C.
CONVERTER
TO LOCOMOTIVE
POWER SUPPLY
TRANSMITTER
& RECEIVER
CHECK
UNIT

RADIO ON PUSHER LOCOMOTIVE


P.T.T.
CONTROL UNIT
D-C. TO A-C.
CONVERTER
TO LOCOMOTIVE
POWER SUPPLY
TRANSMITTER
& RECEIVER
CHECK
UNIT

RADIO ON TRIMMER LOCOMOTIVE

Figure 8. All radio with check system for use in hump yards.

If the railroad radio is equipped with a dependable self-checking system*, it can be used to continue yard operation under adverse weather conditions during which it would not be practicable to operate without radio. See Figure 8.

The hump conductor also calls on the trimmer engine for various duties in addition to its regular function of moving cars along the classification tracks. For example, some cars are marked "Do Not Hump" - perhaps they contain explosives or fragile lading. These cars must be escorted by the trimmer engine from the top of the hump to the proper class track. This move calls for good coordination and the many necessary details are quickly arranged and smoothly carried out with the aid of radio.

C. Terminal Operation

Operations in a terminal area will be well served by radio, making it possible to direct the operation of terminal equipment much more effectively using the two-way radio phone which railroad radio will make available to the yard or train masters and the locomotives. Special shipments and deliveries and emergencies can be more easily and quickly handled when instant phone communication is available.

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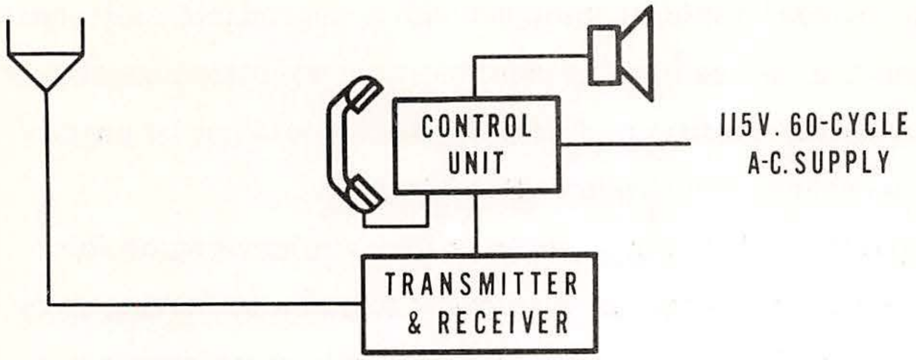
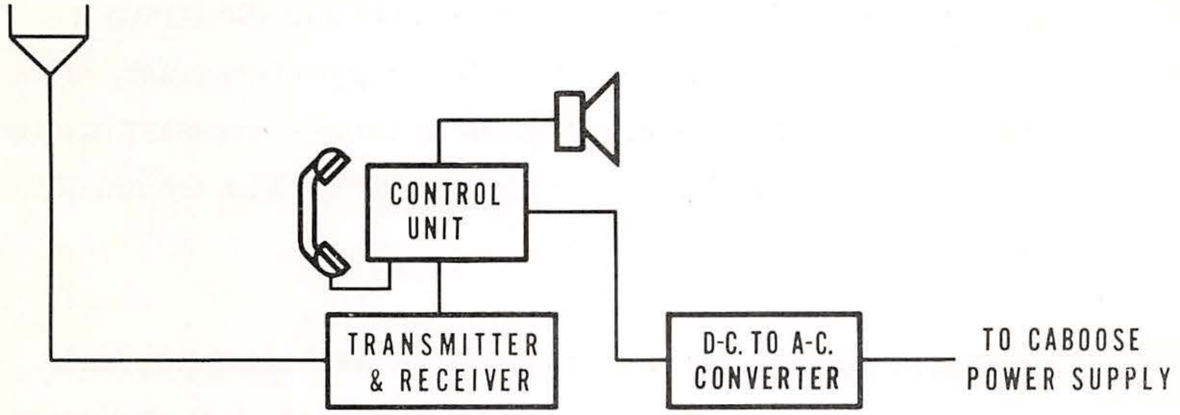
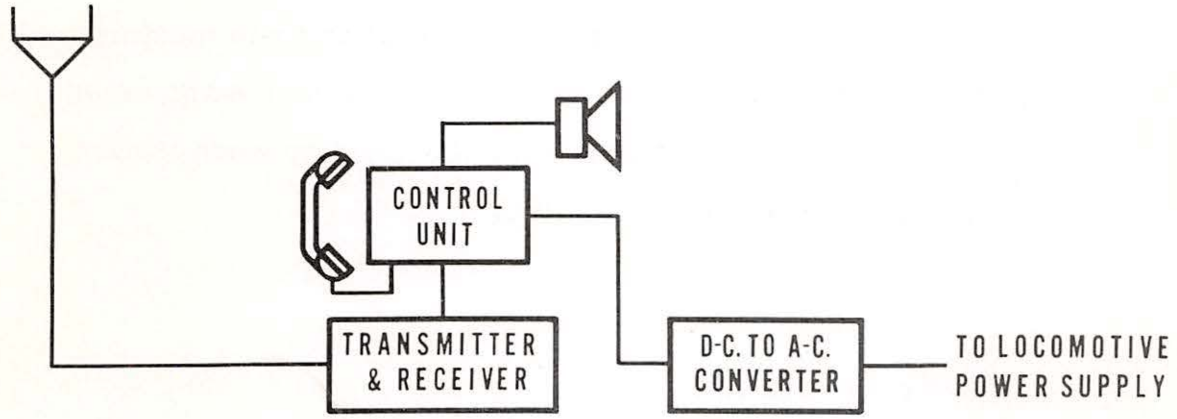
* Such a system is installed at Selkirk. The control units on the locomotives have a check light. If the light goes out and no voice is heard, it indicates a probable failure of the radio system. The engineman should stop his train pending receipt of further instructions, either by the radio when it is restored, or by emergency means of communication.


CONTROL UNIT
115V. 60-CYCLE A-C. SUPPLY
TRANSMITTER & RECEIVER

RADIO AT WAYSIDE LOCATION


CONTROL UNIT
TRANSMITTER & RECEIVER
D-C. TO A-C. CONVERTER
TO CABOOSE POWER SUPPLY

RADIO ON CABOOSE


CONTROL UNIT
TRANSMITTER & RECEIVER
D-C. TO A-C. CONVERTER
TO LOCOMOTIVE POWER SUPPLY

RADIO ON LOCOMOTIVE

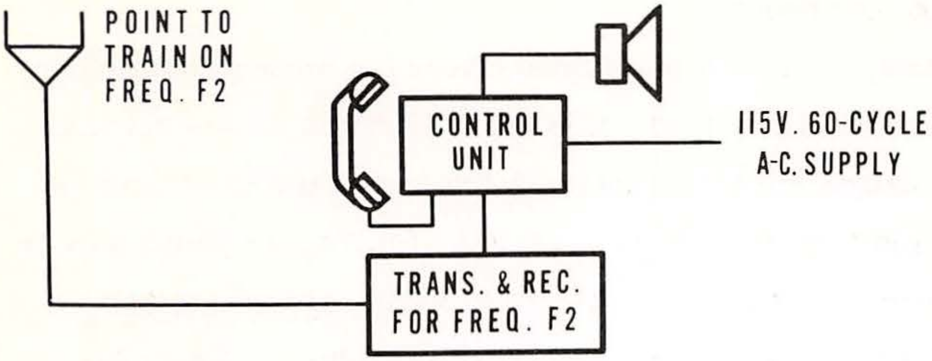
Figure 9. All radio with end-to-end and point-to-train on the same frequency.

D. Main Line Operation

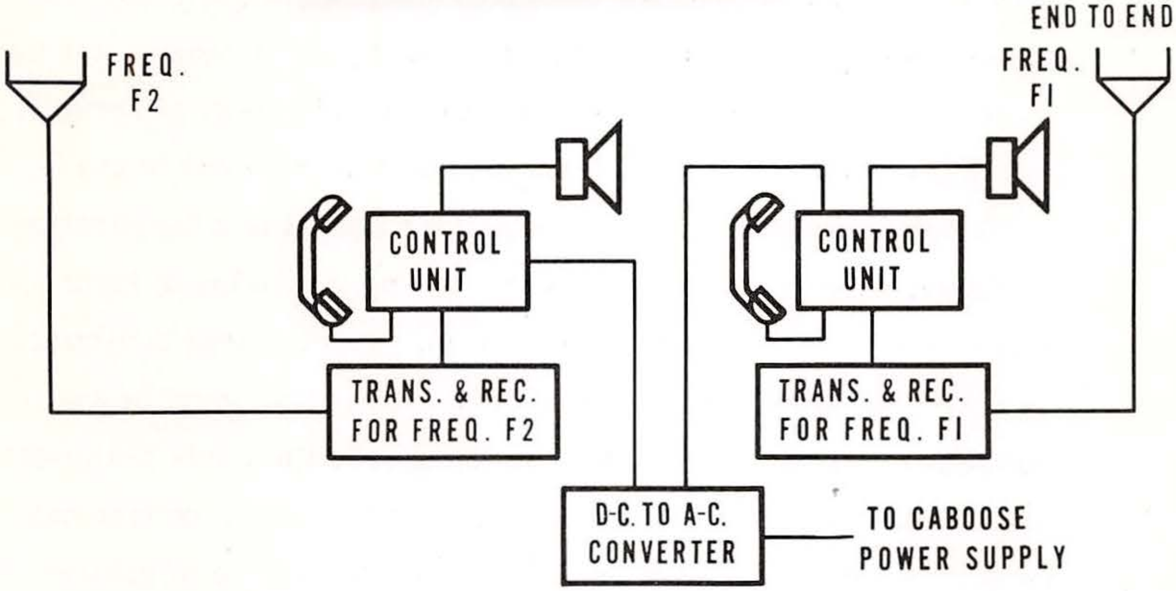
Train operation on main lines offers the most romantic part for railroad radio to play. It is the application to this service that has caught the public interest and can be the most exciting. It is not too hard to imagine a variety of situations which will be reported by railroad radio in time to avoid serious damage or delay. Trains in the same vicinity will be able to talk to one another and to one or more land stations. On freight trains end-to-end phone communication will permit the train crew to handle their train much more effectively, particularly under adverse weather and operating conditions. Time will be saved in preparing a train for departure and in entering and leaving passing sidings and many other places enroute where it helps to know just where the other end of the train is, so as to clear switches or road crossings - or to spot a crippled car that must be cut out before serious trouble starts. These are the kinds of things that railroad radio in end-to-end and point-to-train service can do day in and day out to earn its keep and contribute to greater safety and increased traffic capacity. It can do much to prevent accidents and it can summon assistance promptly when accidents do occur, especially in remote places and in bad weather.

One arrangement employs the same radio frequency for both end-to-end and point-to-train services, Figure 9.

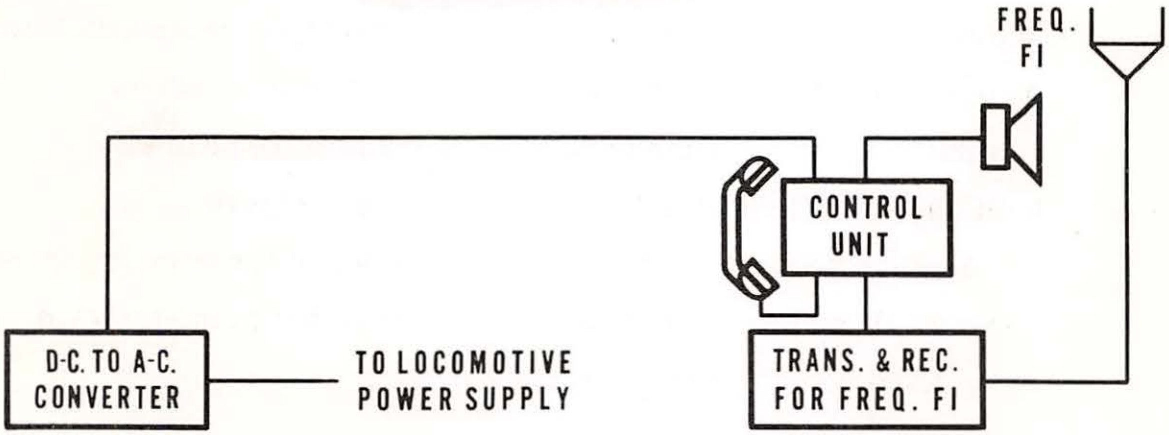
Another scheme uses a separate frequency for point-to-train service. It makes simultaneous end-to-end and point-to-train communication available, Figure 10.


POINT TO TRAIN ON FREQ. F2
CONTROL UNIT
115V. 60-CYCLE A-C. SUPPLY
TRANS. & REC. FOR FREQ. F2

RADIO AT WAYSIDE LOCATION


FREQ. F2
END TO END FREQ. F1
CONTROL UNIT
CONTROL UNIT
TRANS. & REC. FOR FREQ. F2
TRANS. & REC. FOR FREQ. F1
D-C. TO A-C. CONVERTER
TO CABOOSE POWER SUPPLY

RADIO ON CABOOSE


FREQ. F1
CONTROL UNIT
D-C. TO A-C. CONVERTER
TO LOCOMOTIVE POWER SUPPLY
TRANS. & REC. FOR FREQ. F1

RADIO ON LOCOMOTIVE

Figure 10. All radio with point-to-train on a separate frequency.

E. Authority and Rules for Operation of a Railroad Radio Service

1. Allocation of frequencies

On December 31, 1945, the Federal Communications Commission made a number of frequencies available for a railroad radio service and set forth the rules for its operation.

To train radio stations, primarily stations on board railroad rolling stock, and for land stations for use in communicating with stations on board railroad rolling stock, the Federal Communications Commission allocated a block of 60 frequencies extending from 158 to 162 megacycles. These frequencies will be augmented with other specific frequencies to be shared with television in the various television channels located at points in the radio spectrum starting with the 44- to 50-megacycle channel and ending with the 210- to 216-megacycle channel. Other frequencies are available for experimental work in connection with railroad operation. Some are in the ultra-high-frequency band, which may hold special advantages for railroad radio.

2. Who may operate the stations

Stations may be operated by persons having a second-class radio operator's license or by railroad employees who have qualified under the new F.C.C. order No. 126*. This order permits railroad employees to operate railroad radio transmitting equipment without holding a radio operator's license, provided they meet the qualifications of this order.

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* A copy of this order is included starting on page 25.

IV. ELECTRONIC EQUIPMENT

A. For G-R-S Inductive Carrier

The electronic equipment for the inductive carrier train communication system consists of a narrow-band FM transmitter and receiver for operation on 70 to 200 kc. The transmitter, Figure 11, has an output of 35 to 40 watts for mobile units and 2 watts for wayside

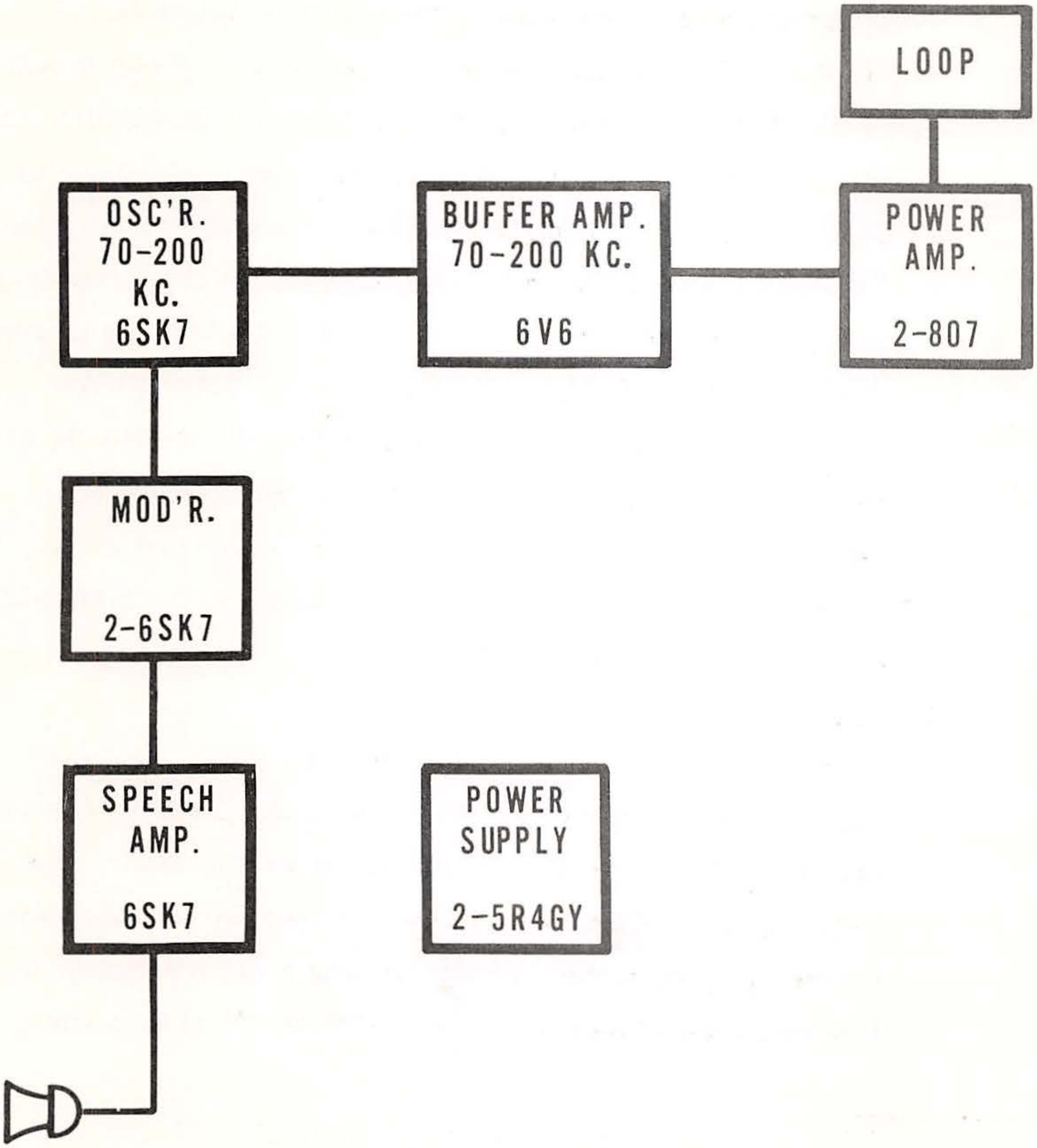
LOOP
OSC'R. 70-200 KC. 6SK7
BUFFER AMP. 70-200 KC. 6V6
POWER AMP. 2-807
MOD'R. 2-6SK7
SPEECH AMP. 6SK7
POWER SUPPLY 2-5R4GY

Figure 11. Inductive carrier transmitter, 70 to 200 kc.

stations. It employs a deviation ratio* of 1 to 1 and is designed for operation on 117 volts 60 cycles.

The receiver, Figure 12, is of the single-conversion heterodyne type and has a sensitivity of approximately 1.0 microvolt. It is equipped with a differential action squelch circuit and provides an audio output of 5 watts. It is designed to be operated from 117 volts 60 cycles. The set, consisting of a transmitter and a receiver, draws approximately 130 watts when receiving and 270 watts for a mobile station and 200 watts for a wayside station when transmitting.

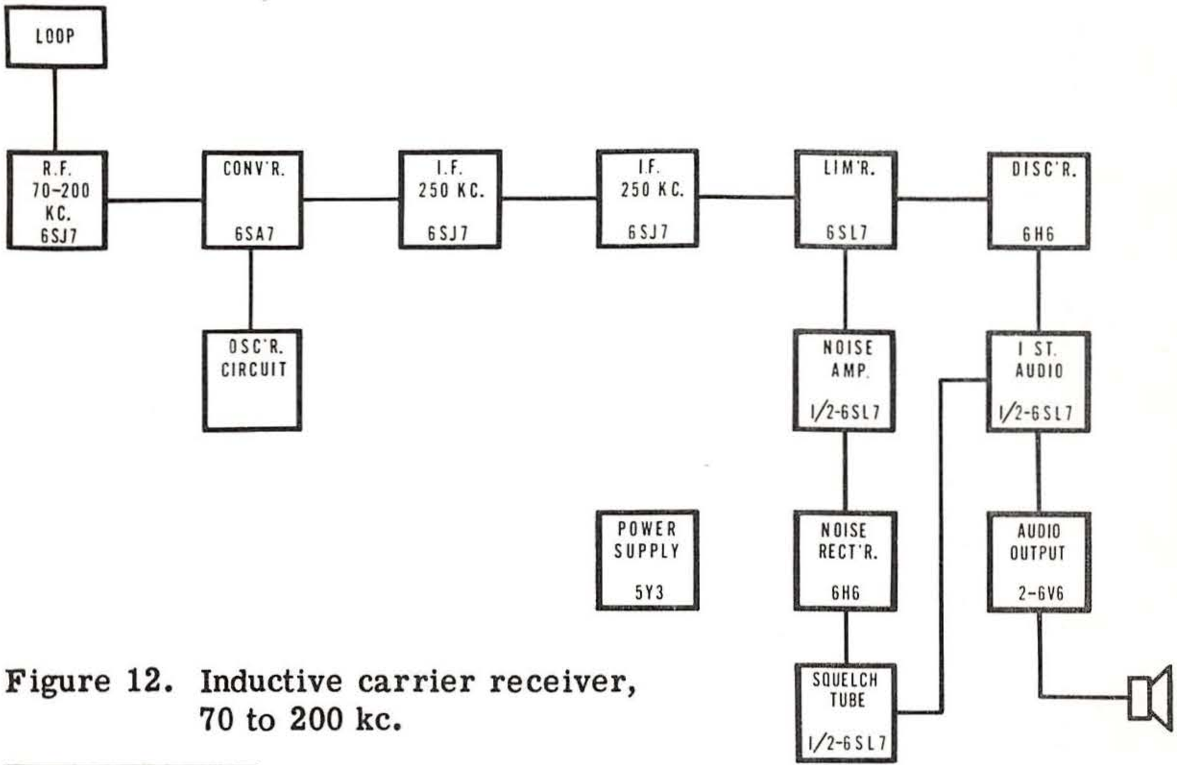
LOOP
R.F. 70-200 KC. 6SJ7
CONV'R. 6SA7
I.F. 250 KC. 6SJ7
I.F. 250 KC. 6SJ7
LIM'R. 6SL7
DISC'R. 6H6
OSC'R. CIRCUIT
NOISE AMP. 1/2-6SL7
I ST. AUDIO 1/2-6SL7
POWER SUPPLY 5Y3
NOISE RECT'R. 6H6
AUDIO OUTPUT 2-6V6
SQUELCH TUBE 1/2-6SL7

Figure 12. Inductive carrier receiver, 70 to 200 kc.

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* The deviation ratio is the ratio of the maximum deviation of the carrier frequency to the modulating frequency. Frequency deviation is half the difference between the maximum limits between which the instantaneous frequency of the modulated wave varies. Assume a modulation frequency of 3,000 cycles and a deviation ratio of 1 to 1. Then the maximum deviation of the carrier frequency is ± 3,000 cycles. If the carrier frequency is 200,000 cycles, it will vary between the limits of 197,000 and 203,000 cycles.

At a mobile station the set is connected to a wire loop which is used for both transmitting and receiving. At a wayside station the set is coupled to the line wires of the railroad pole line. Only one loop or line coupling is used at each station since the operation is simplex, i.e., transmission can take place in one direction only at a time.

B. For G-R-S Space Radio

The electronic equipment for the space radio train communication system consists of an FM transmitter and receiver for operation on 148 to 162 mc. The transmitter, Figure 13, is crystal controlled and has an r-f. output of 15 to 20 watts. It is designed to be operated from 117 volts 60 cycles.

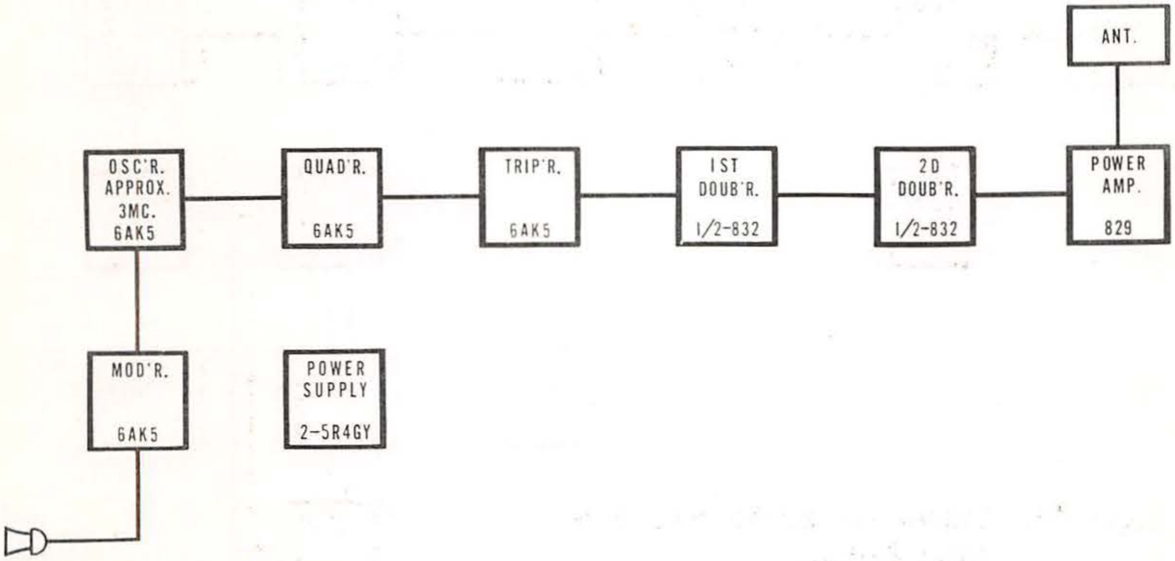
ANT.
OSC'R. APPROX. 3MC. 6AK5
QUAD'R. 6AK5
TRIP'R. 6AK5
1ST DOUB'R. 1/2-832
2D DOUB'R. 1/2-832
POWER AMP. 829
MOD'R. 6AK5
POWER SUPPLY 2-5R4GY

Figure 13. Radio transmitter, v-h-f. 148 to 162 mc.

The receiver, Figure 14, is of the double-conversion heterodyne type. It has a crystal controlled oscillator. The sensitivity is approximately 1.0 microvolt. It furnishes 5 watts of audio power and has a differential action squelch circuit. It is designed to be operated from 117 volts 60 cycles. The set, consisting of a transmitter and a receiver, draws approximately 130 watts when receiving and 270 watts when transmitting.

The set usually employs the same antenna for receiving and transmitting because simplex operation is used. The operation of the push-to-talk button automatically switches the antenna.

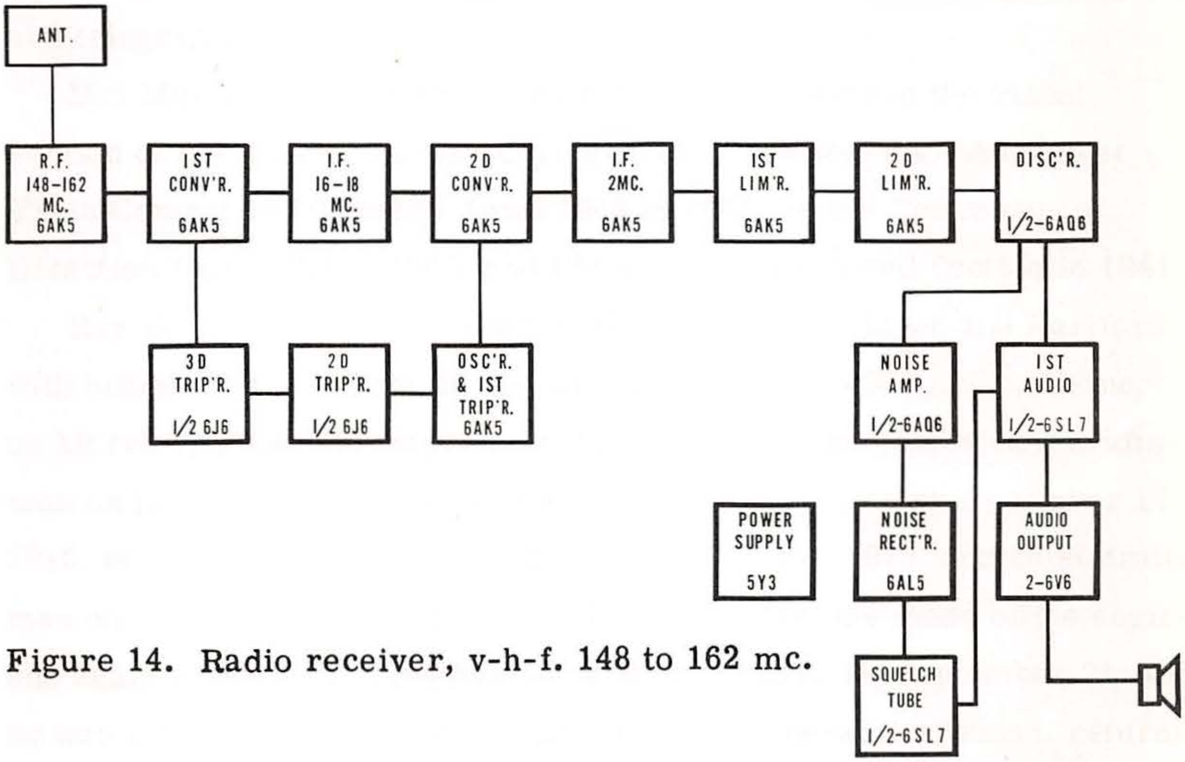
ANT.
R.F. 148-162 MC. 6AK5
1ST CONV'R. 6AK5
I.F. 16-18 MC. 6AK5
2D CONV'R. 6AK5
I.F. 2MC. 6AK5
1ST LIM'R. 6AK5
2D LIM'R. 6AK5
DISC'R. 1/2-6AQ6
3D TRIP'R. 1/2 6J6
2D TRIP'R. 1/2 6J6
OSC'R. & 1ST TRIP'R. 6AK5
NOISE AMP. 1/2-6AQ6
1ST AUDIO 1/2-6SL7
POWER SUPPLY 5Y3
NOISE RECT'R. 6AL5
AUDIO OUTPUT 2-6V6
SQUELCH TUBE 1/2-6SL7

Figure 14. Radio receiver, v-h-f. 148 to 162 mc.

V. TESTS AND TEST RESULTS

A. Tests in the New York Central Hump Yard at Selkirk, N. Y.

A trial installation of G-R-S Company railroad radio has been in service for a year and a half at the westbound hump yard of the New York Central Railroad at Selkirk, N. Y. It is space radio equipment operating on 39.14 mc. and is equipped with the G-R-S checking system. The "hump", three locomotives, and an automobile are equipped. A dipole coaxial antenna on a 30-foot pole is used at the crest of the hump. A quarter-wave whip antenna is used on each locomotive. The transmitters have an r-f. output of approximately 15 watts.

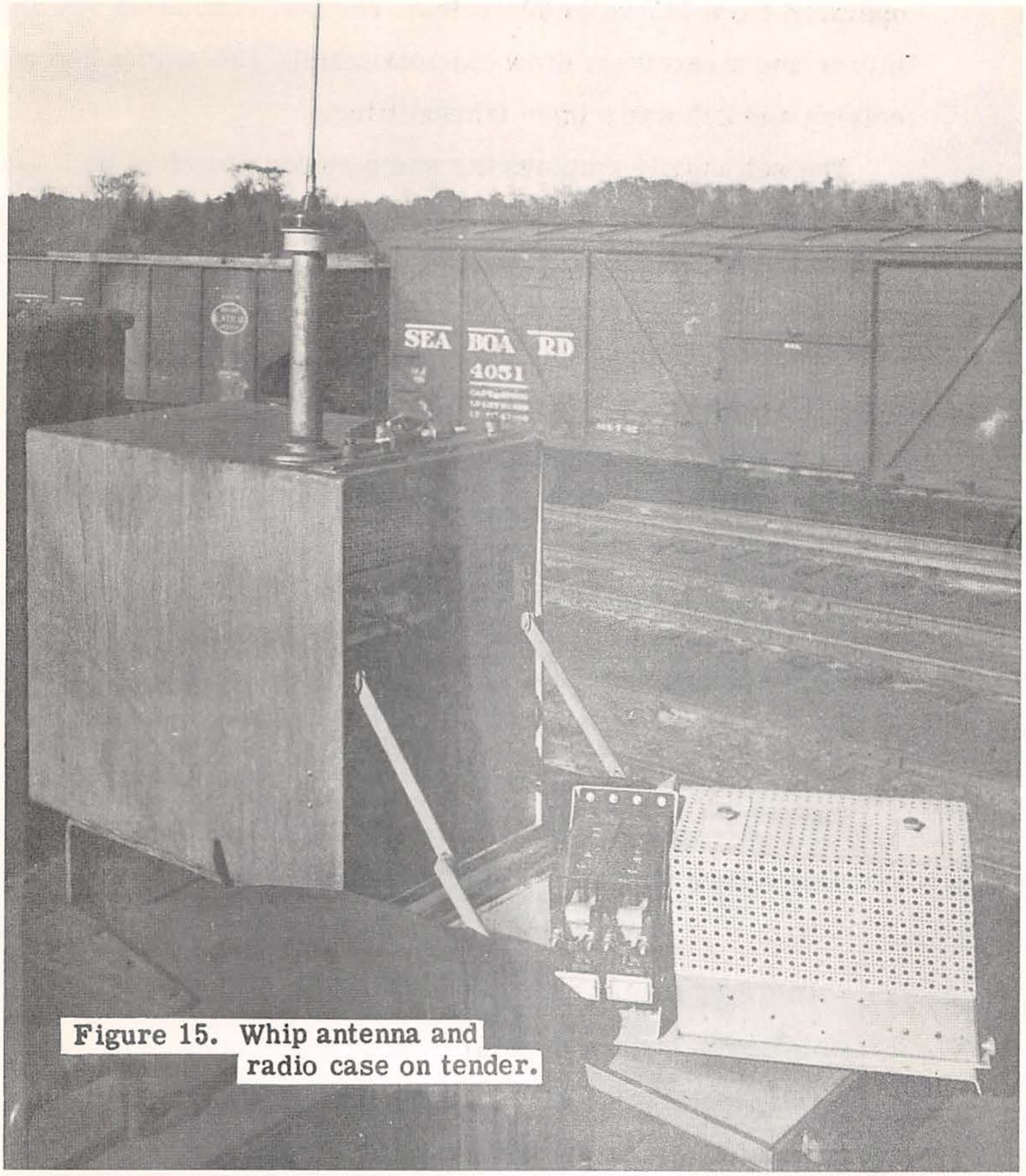

Figure 15. Whip antenna and radio case on tender.

This installation has been observed in actual operation and it has given excellent communication with ample radio coverage for all operations. Solid communication is also obtained between the automobile and the hump yard,with the automobile in Albany, which is about ten miles from the yard. The trial installation will soon be replaced with a permanent installation operating in the 160-mc. band.

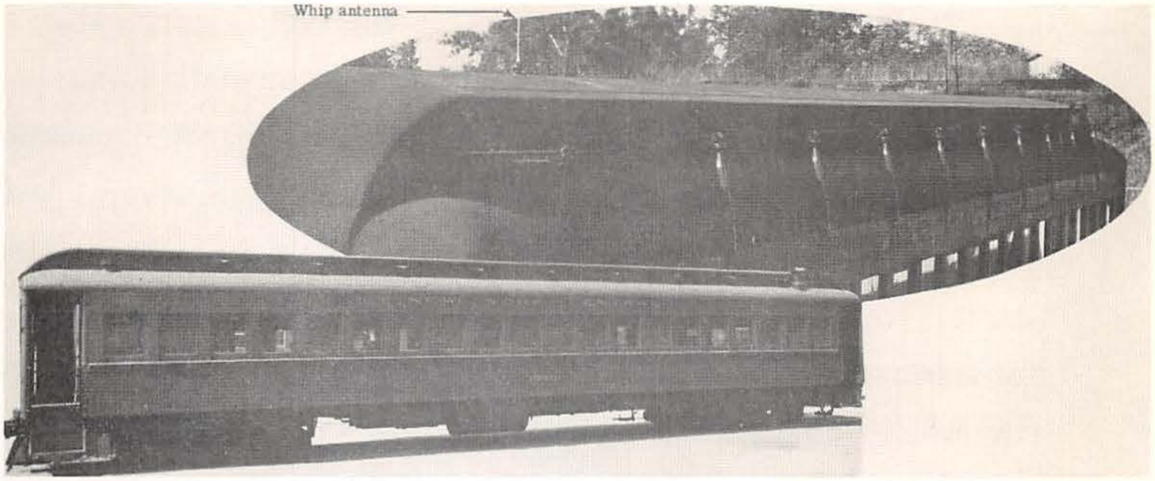

Figure 16. Laboratory test car. Loop wire and whip antenna (inset).

B. End-to-End and Point-to-Train Tests on Syracuse Division of New York Central Railroad

During the latter part of 1945 a series of tests were made on the Syracuse Division of the New York Central Railroad. The General Railway Signal Company and the General Electric Company cooperated with the New York Central Railroad in this work which included tests of both inductive carrier and space radio equipment.

Two steel laboratory cars were equipped with test facilities and living quarters. Each car had a set of inductive carrier equipment and also a set of space radio equipment. A caboose was equipped with loop wires for tests with carrier.

Two wayside stations were equipped with carrier and radio, one at Jordan, N. Y., and the other at Rochester, N. Y. There are two pole lines along the Syracuse division of the railroad and arrangements were made so that the wayside station at Jordan could be coupled to both lines in parallel or connected between them for tests with horizontal loops on the mobile stations.

The Jordan station had a coaxial dipole radio antenna at a height of approximately 50 feet. The Rochester station was coupled to the north line for the inductive carrier communication. For space radio a directional antenna consisting of several half-wave sections arranged to give a horizontal figure eight distribution was mounted on top of a three-story building at a height of approximately 60 feet. The array was oriented so as to direct the westerly lobe of the radiation pattern along the railroad tracks west of Rochester towards Batavia. The opposite lobe was therefore somewhat north of the New York Central tracks eastward from Rochester.

For carrier loops each car had a single No. 10 AWG stranded insulated copper wire carried on pole-top insulators along each edge of the car roof. The car frame was used for the return path for both wires except for a few tests in which the two wires were connected in series to form a horizontal loop.

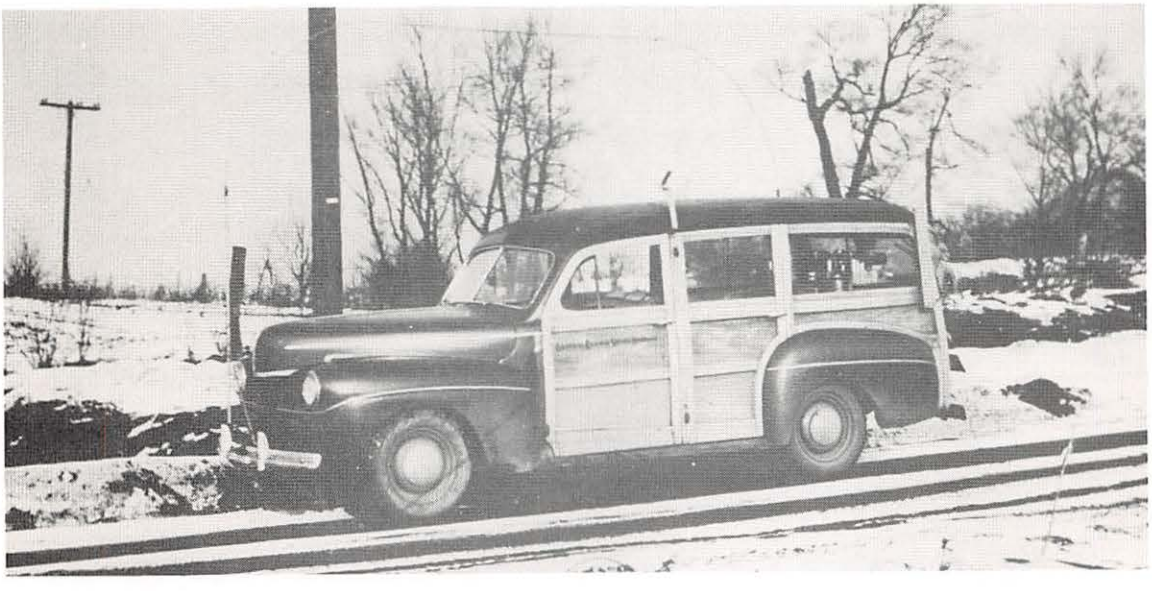

Figure 17. Radio test station wagon equipped with loop wire and J-type antenna.

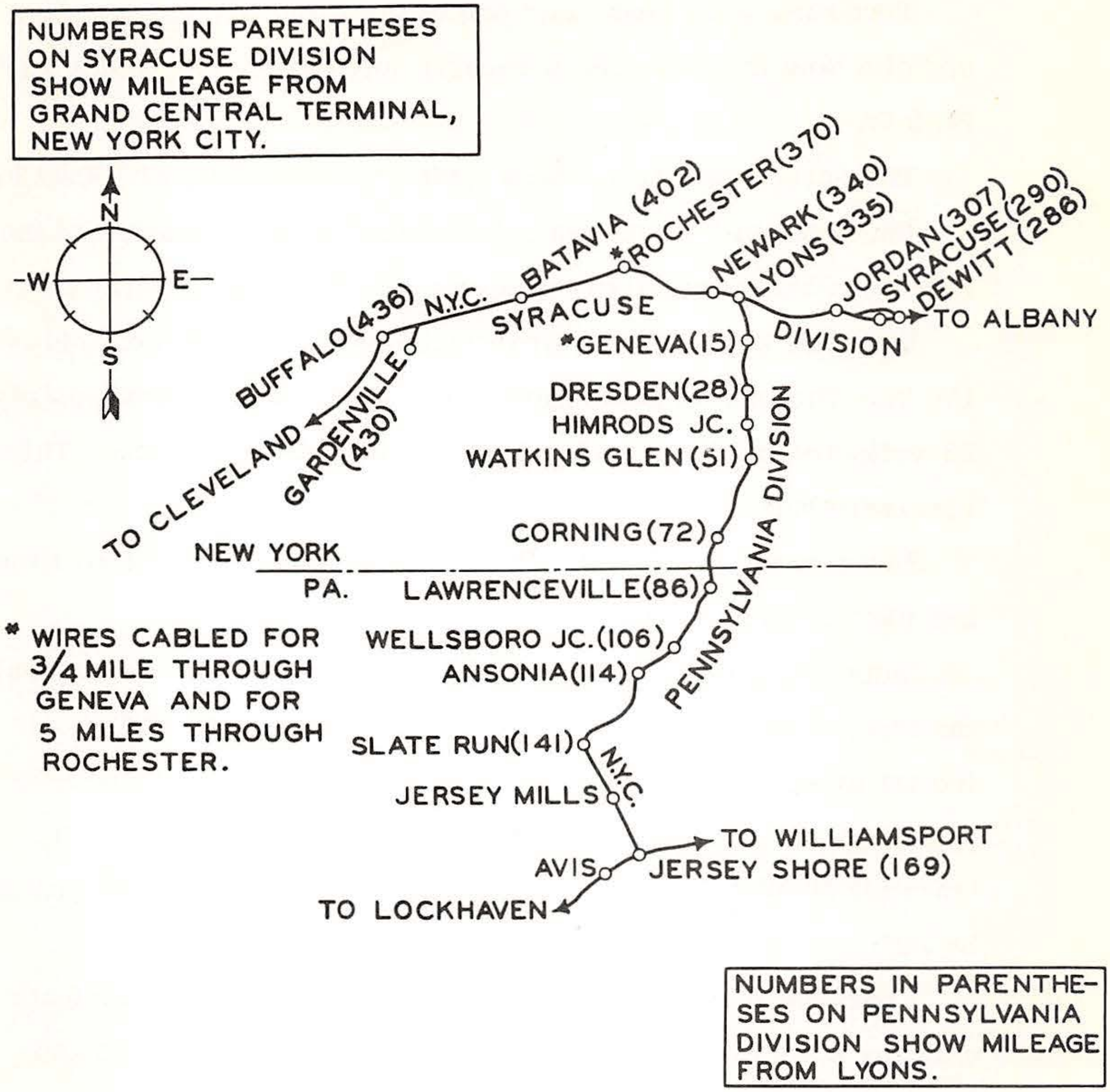
NUMBERS IN PARENTHESES ON SYRACUSE DIVISION SHOW MILEAGE FROM GRAND CENTRAL TERMINAL, NEW YORK CITY.
N
E
S
W
BUFFALO (436)
N.Y.C.
BATAVIA (402)
*ROCHESTER (370)
NEWARK (340)
LYONS (335)
JORDAN (307)
SYRACUSE (290)
DEWITT (286)
TO ALBANY
SYRACUSE DIVISION
GARDENVILLE (430)
TO CLEVELAND
*GENEVA (15)
DRESDEN (28)
HIMRODS JC.
WATKINS GLEN (51)
CORNING (72)
NEW YORK
PA.
LAWRENCEVILLE (86)
WELLSBORO JC. (106)
ANSONIA (114)
PENNSYLVANIA DIVISION
SLATE RUN (141)
N.Y.C.
JERSEY MILLS
TO WILLIAMSPORT
AVIS
JERSEY SHORE (169)
TO LOCKHAVEN
* WIRES CABLED FOR 3/4 MILE THROUGH GENEVA AND FOR 5 MILES THROUGH ROCHESTER.
NUMBERS IN PARENTHESES ON PENNSYLVANIA DIVISION SHOW MILEAGE FROM LYONS.

Figure 18. Map of territory where tests were made.

For radio each car had a quarter-wave whip antenna mounted on the steel roof of the car.

Two station wagons were also used in these tests. One was equipped with both carrier and radio sets and the other with carrier only.

Test runs were made with one of the radio test cars at each end of a long freight train in regular duty between Syracuse and Buffalo.

The space radio tests were made on a frequency of 160.425 mc. The transmitters had an r-f. output of 15 to 20 watts and the receivers had a sensitivity of approximately 1 microvolt.

Inductive carrier tests were made on 88 kc., 135 kc., and 170 kc. The mobile transmitters had an output of approximately 35 watts and the fixed transmitters about 1/2-watt output. The receivers had a sensitivity of about 1.0 microvolt.

Space radio gave solid end-to-end communication at all times and places during the tests.

Inductive carrier gave end-to-end communication throughout the tests, except where the wayside line wires were absent, or too far away, or in cable.

The Jordan station was able to communicate with the test train for about 12 to 15 miles by space radio and about 50 miles by inductive carrier.

From the Rochester station it was possible to communicate with the train by space radio for about 30 miles westward and 15 miles eastward. Communication by carrier between the test train and the Rochester station was good for 30 miles and fairly good up to 60 miles westward.

C. End-to-End, Point-to-Train Tests, Pa. Div., NYCRR

A test run over the Pennsylvania Division of the New York Central Railroad from Lyons, N. Y., to Avis, Pa., and return was made principally to observe the operation of the 160-megacycle space radio communication from end-to-end of a long freight train when operating in a crooked valley. It was thought that high hills and sharp curves might seriously interfere with radio transmission at this frequency.

The same test equipment used for the Syracuse Division tests was employed for this test run. The radio cars were placed at the two ends of a long freight train in regular service. Two station wagons were used for portable way stations.

The run included the gorge of Pine Creek where for many miles the railroad follows the winding stream with steep wooded hillsides rising 300 to 800 feet above the track. In many places the two ends of the test train were separated by a steep hill that completely blocked the line of sight between the test cars, but solid radio communication was maintained throughout the tests. There is reason to believe that the radio signal was reflected around the curves by the opposite walls of the gorge, since at one location just south of Corning a reduction in signal strength without loss of communication was noted. At this point the two ends of the train were separated by a steep hill with open country on the convex side of the curve.

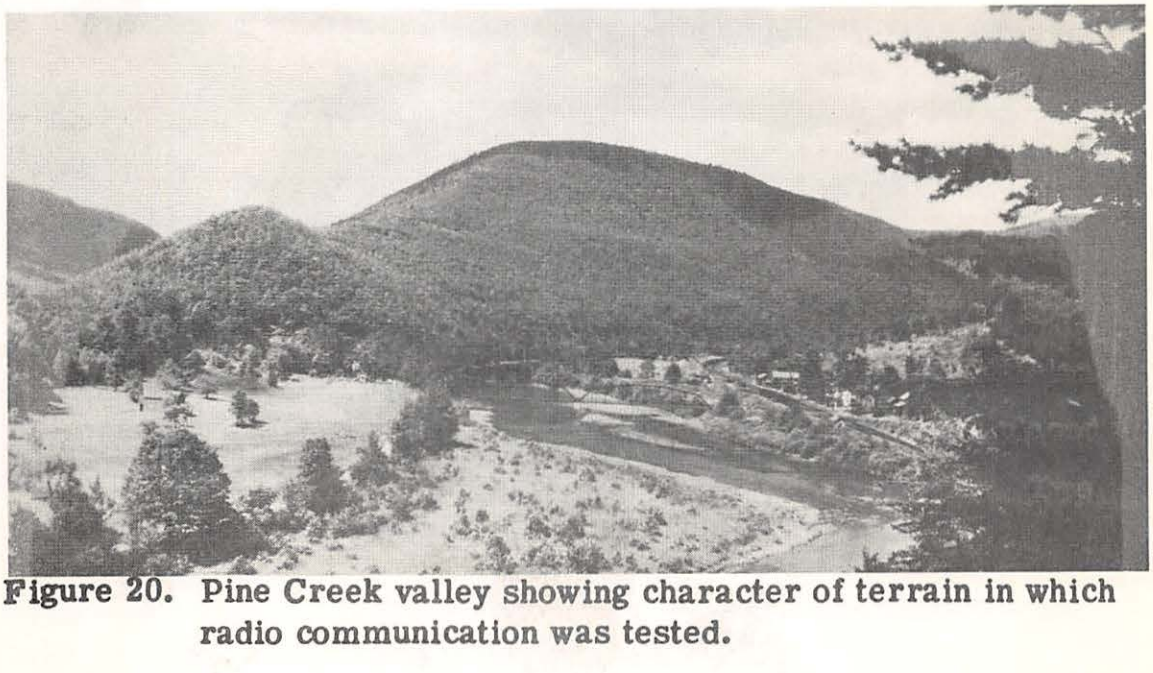

Figure 20. Pine Creek valley showing character of terrain in which radio communication was tested.

The performance of the inductive carrier equipment on this run was not expected to disclose anything essentially new or different. As was expected, communication by inductive carrier was possible when line wires were present. However, point-to-train tests with carrier showed that the attenuation of the carrier signal along the line wires was greater than on the main line tests. This is probably due to the fact that there is but one pole line carrying only 6 or 7 wires along the Pennsylvania Division, compared with two pole lines each having 20 to 30 wires on the main line.

Successful point-to-train communication was established by space radio using the station wagon for a land station at several different places along the railroad. However, there were not enough data taken to establish the operating range for space radio on this test run.

V. CONCLUSION

There are many engineering problems to be solved, but railroad radio is well on its way to successful application. It has been well received and should soon play an important part in railroad operation.

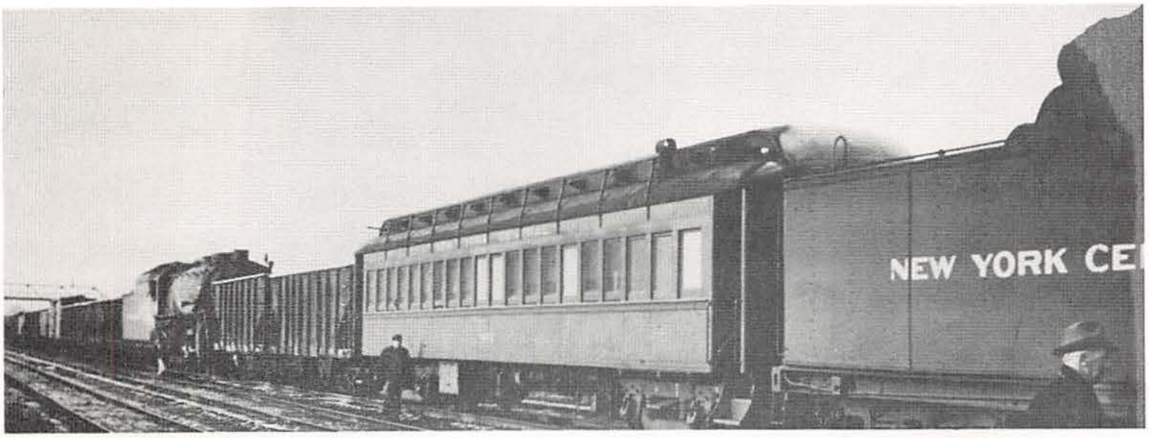

Figure 19. Test train on Pennsylvania Division of the New York Central Railroad.

The following is a transcript of the F.C.C. Order No. 126 mentioned in Mr. Hailes' talk:

FEDERAL COMMUNICATIONS COMMISSION 84077
Washington, D. C.

ORDER NO. 126

At a session of the Federal Communications Commission, held at its offices in Washington, D. C., on the 21st day of August, 1945;

WHEREAS, Section 318 of the Communications Act of 1934, as amended, provides that the operation of the transmitting apparatus of licensed radio stations may be carried on only by persons holding an operator's license issued by this Commission; and

WHEREAS, the Commission is authorized to waive the provisions of said Section 318 in certain cases, provided the Commission shall find that the public interest, convenience, or necessity will be thereby served; and

WHEREAS, on June 1, 1945, the Association of American Railroads by J. J. Pelley, its President, filed with the Commission a duly verified petition requesting the issuance of an order permitting railroad employees to engage, without operator licenses, in the operation of radio transmitting equipment used in connection with railroad operations; and

WHEREAS, it appears from said petition that the number of Class I railway employees who might be required to use radio transmitting equipment in connection with their duties totals 463,568 and that this total would be increased by inclusion of Class II and Class III railroad employees; and

WHEREAS, it appears that the qualification of such a large number of employees presents certain difficulties; and

WHEREAS, the Association of American Railroads has prepared for the adoption of its member roads a comprehensive set of Railroad Radio General and Operating Rules governing the use of radio transmitting equipment by the employees of the individual member roads; and

WHEREAS, the Association's proposed Railroad Radio General and Operating Rules cover those provisions of the Communications Act, the Commission's Rules and Regulations, and the General Radio Regulations, Cairo Revision, with respect to which applicants for restricted radiotelephone permits are presently examined; and

WHEREAS, it is proposed that all railroad employees who operate radio transmitting equipment will be examined by railroad examiners with respect to their knowledge of such Rules; and

WHEREAS, the waiver of the provisions of Section 318 of the Communications Act sought by the Association does not extend to making adjustments to any transmitting apparatus, which adjustments would continue to be made only by duly licensed operators; and

WHEREAS, from a study of the Association's petition and the evidence presented in Commission Docket Proceedings Nos. 6593 and 6651 entitled, respectively, "In the Matter of the Investigation of the Establishment and Use of Radiocommunications Systems in Railroad Operations", and "In the Matter of Allocation of Frequencies to the Various Classes of Non-Governmental Services in the Radio Spectrum from 10 kilocycles to 30,000,000 kilocycles", it appears that a waiver of the provisions of Section 318 of the Communications Act, so as to permit railroad employees to engage, without operator licenses, in the operation of radio transmitting equipment used in connection with railroad operations, would promote the use of radio in that industry, thereby increasing the efficiency and safety of railroad operations, and thus serving the public interest, convenience, and necessity;

IT IS ORDERED, that, subject to the conditions hereinafter stated, the provisions contained in Section 318 of the Communications Act of 1934, as amended, BE, AND THEY ARE HEREBY, WAIVED, insofar as such provisions require that railroad employees hold operators' licenses in order to operate radio transmitting apparatus authorized for use in connection with railroad operations either under an experimental radio station license or a station license issued in accordance with such railroad radio service rules as may hereafter be issued by this Commission; and the employees of Class I, II, and III Railroads of the United States, BE, AND THEY ARE HEREBY, AUTHORIZED to engage, without operators' licenses, in operation of radio transmitting apparatus authorized for use in connection with railroad operations provided, however:

1. The terms of this Order shall apply only to the employees of those railroads who shall have adopted and published Railroad Radio General and Operating Rules in the form prepared by the Association of American Railroads and attached hereto. Any individual railroad which desires to adopt rules not in the form attached hereto shall, for the purposes of this Order, first obtain the prior written approval of the Commission to the changes proposed.
2. The terms of this Order shall apply only to those railroad employees who shall have successfully passed an examination given by railroad examiners on the attached Railroad Radio General and Operating Rules. The first such examination shall be given prior to the operation of any radio transmitting apparatus by the employee and re-examinations shall thereafter be given at intervals not in excess of two years.

3. The terms of this Order shall apply only to the employees of those railroads who maintain suitable records showing the name and position of all employees who have been examined with respect to the attached Railroad Radio General and Operating Rules, the date of the employee's last successfully completed examination, and the name of the railroad examiner. Such records shall be made available to duly accredited representatives of the Federal Communications Commission upon request.
4. The terms of this Order shall not be construed to authorize any railroad employee to make adjustments to any radio transmitter. Any needed adjustments of the transmitter of a railroad radio station that may affect its proper operation shall be regularly made by or in the presence of an operator duly licensed by this Commission, holding a first or second class license, either telephone or telegraph, who shall be responsible for the proper operation of the equipment.
5. The radio equipment operated by railroad employees pursuant to the authorization given by this Order shall be so designed that none of the operations necessary to be performed during normal use of the equipment may result in any unauthorized radiation.

IT IS FURTHER ORDERED, that this Order shall become effective upon issuance and shall remain in effect until the further order of the Commission.

BY THE COMMISSION

T. J. Slowie
Secretary

RAILROAD RADIO

84078

General and Operating Rules

General

The following rules and requirements cover use of railroad radio systems and govern employees using such systems:

A. Definition: A railroad radio communication system is one employing radio for the transmission of intelligence between moving equipment, between moving equipment and a fixed point, or between fixed points.

B. Radio communication systems are under the jurisdiction of the Federal Communications Commission. The railroad company and its employees are governed by the Commission's operating rules. Violation is a federal offense for which severe penalties are provided.

C. In order to operate a radio transmitting set a railroad employee must read and study the following rules and pass an examination thereon. Such examinations will be given by railroad examiners.

Operating Rules

1. All employees, except those specifically authorized to do so, are prohibited from making any adjustments to a railroad radio set. Employees so authorized must carry their FCC operator license or verification card when on duty. If it appears that a radio transmitter is not operating properly, its use shall be discontinued and the designated railroad official notified as soon as possible.
2. No employee shall knowingly transmit any false distress communication, any unnecessary, irrelevant or unidentified communication, nor utter any obscene, indecent, or profane language via radio.

3. No employee shall divulge or publish the existence, contents, purport, effect or meaning of any communication (distress communications excluded) except to the person for whom the communication is intended or to another employee of the railroad whose duties may require knowledge of the communication. The above applies either to communications received direct or to any that may be intercepted.

4. Before transmitting, any employee operating a radio transmitting set shall listen a sufficient interval to be sure that the circuit is not already in use, particularly for distress traffic.

5. A distress call will be preceded by the word "Emergency" repeated three times. Such calls shall be used only to cover initial reports of derailments, storms, washouts, fires, obstructions to tracks, or other matters which would cause serious delay to traffic, damage to property, injury to employees or the traveling public, and shall contain as complete information thereon as possible. All employees shall give absolute priority to communications from another station in distress, and, except in answering or aiding a station in distress, shall refrain from sending any communications until there is assurance that no interference will result to the station in distress.

6. The railroad company is required to answer an official notice of violation of the terms of the Communications Act of 1934, as amended, within three days from receipt of notice and any employees receiving inquiry concerning any violation shall answer such inquiry within 24 hours after receipt of notice.

7. Any employee shall permit inspection of the radio equipment in his charge and all FCC documents pertaining thereto, by a duly

accredited representative of the Federal Communications Commission at any reasonable time.

8. Employees, except in yard operation, shall identify the radio station from which they are calling by prefacing their call with the railroad name, for example, "ABC (Railroad) Caboose Train 92 calling Engine", "XYZ (Railroad) Caboose Train 92 calling Engine Train 89", or "MAIN (Railroad) Engine 547 calling Caboose 1402."
9. In certain cases at crossings, junctions or paralleling tracks some interference may develop with another railroad. In such cases especial care in making identification shall be used and the employees concerned shall cooperate in handling their business by alternating calls and being as brief as possible.
10. If any communication from a station other than another railroad radio station interferes with railroad radio service the railroad employee will endeavor to ascertain the identity of such station and report the occurrence as soon as possible through authorized channels, to the designated railroad official, giving the exact time, nature of the communication and identity of the station, if possible.

Internationally, the word "Mayday" indicates a distress message, the word "Pan", an urgent message and the word "Security", a safety message.* Railroad employees may hear such messages sent by aircraft or, in coastal areas, by boats. Railroad employees hearing such messages must report them immediately through authorized channels to the designated railroad official in addition to taking such appropriate action to relieve the distress as may be possible.

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* "Mayday", from French "m'aider", meaning "to help me", is the SOS of radiotelephony. "Pan", from French "panne", meaning "need", is the XXX of radiotelephony. "Security", from French "sécurité", meaning "safety", is the TTT of radiotelephony.

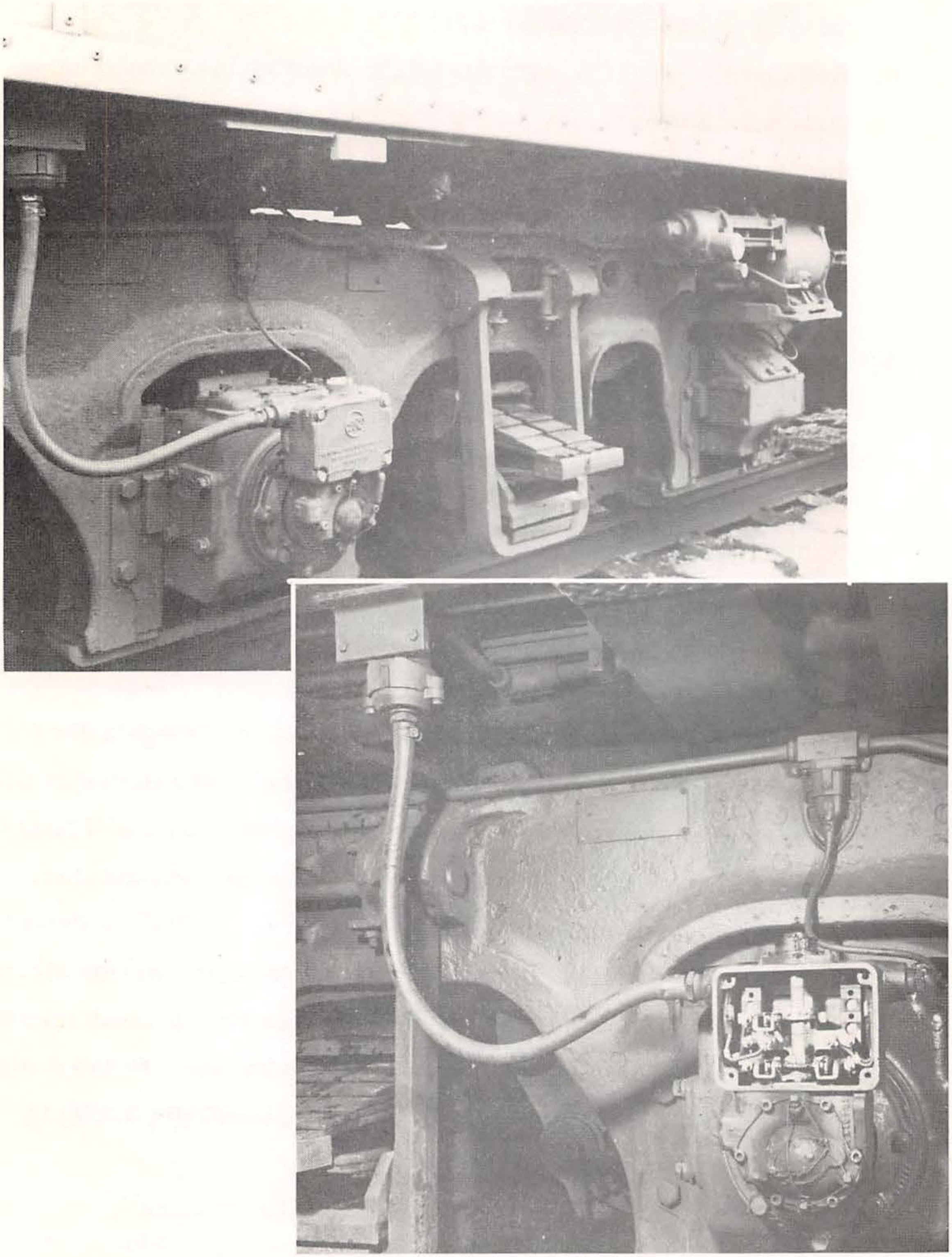


Figure 1. Speed governor mounted on Hyatt journal box.

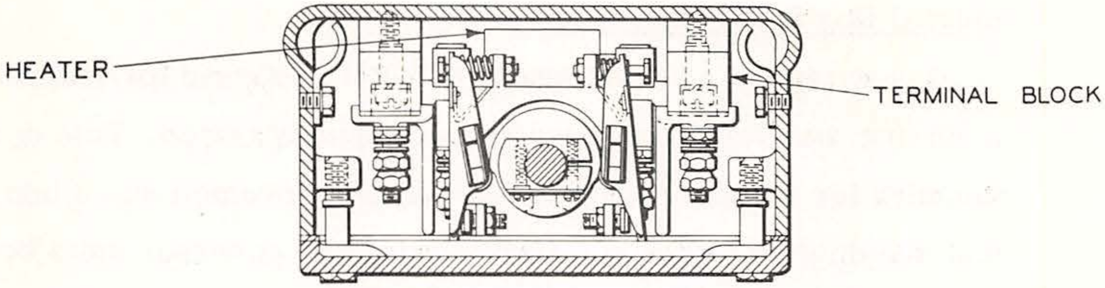
Journal Box Speed Governor

A new type of speed governor (58400), designed for journal box mounting, has been developed and extensively tested. This device is intended for installation on diesel-electric locomotives, since it is not feasible on such engines to install axle-type governor units between wheels because of interference with drive motors and related equipment. The new governor can be mounted on any standard roller bearing journal box by means of suitable adapters and a clamping ring. The combination of journal box, adapter, clamping ring, and gaskets forms a sealed, weathertight unit.

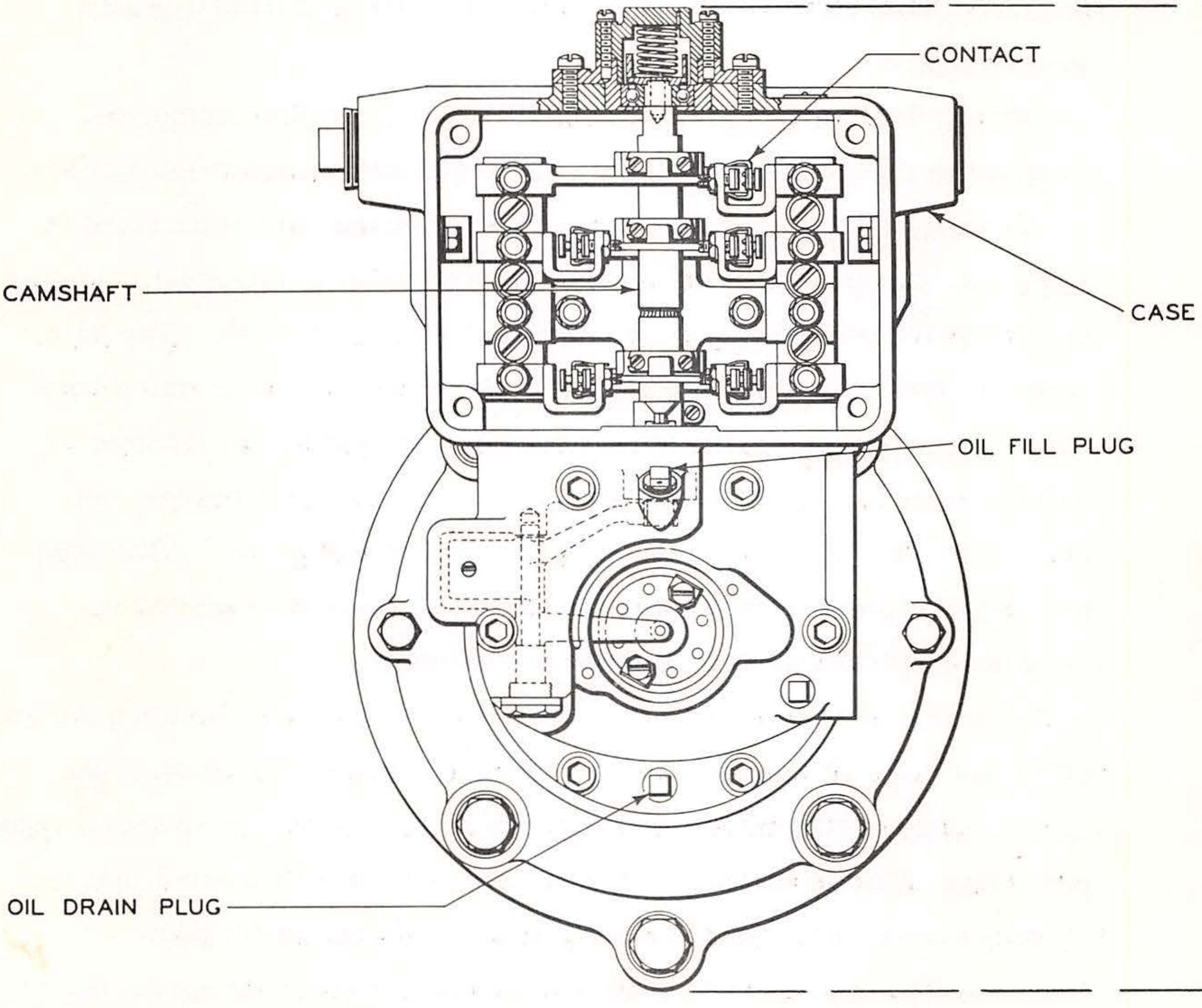
Figure 1 illustrates a typical installation on an Electromotive Corporation locomotive, the unit being mounted on a Hyatt journal box.

The major mechanical features of the governor are illustrated in Figure 2. Connection to the locomotive axle is by a universally-jointed splined shaft, which engages an internal spline on the axle. The axle spline is formed by pressing an internally splined bushing into a hole bored in the axle, as indicated, or may be supplied by the locomotive builder as an axle cap unit. Electrical connections are brought out through a rubber hose to a plug coupler visible in Figure 1. The combination of splined shaft drive and plug-type electrical connections permits easy removal and replacement of units.

As will be seen in Figure 2, a loading spring is used between the end of the splined shaft and the axle to take up end-play. Rotation of the splined shaft is transmitted through a universal joint to a scissors-type centrifuge. This centrifuge, shown in more detail in Figure 3, has its fly-weights arranged symmetrically about a central pivot point, a design which supplies sensitivity to changes in rotational speed, but which is not affected by shocks because of the balanced weight distribution.

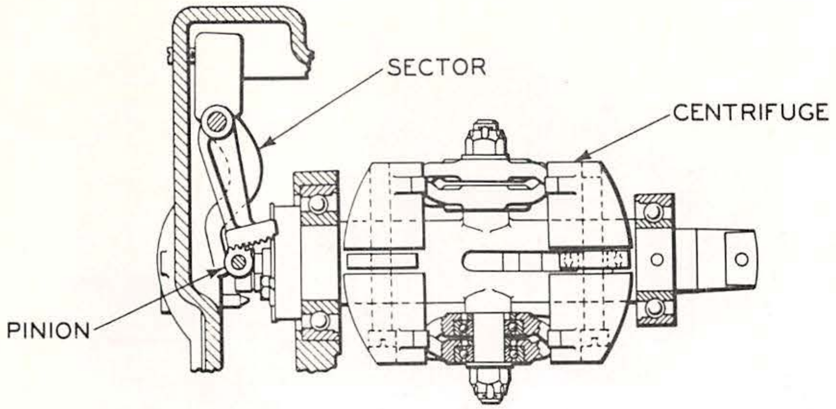

HEATER
TERMINAL BLOCK

(c) Section through contact compartment.

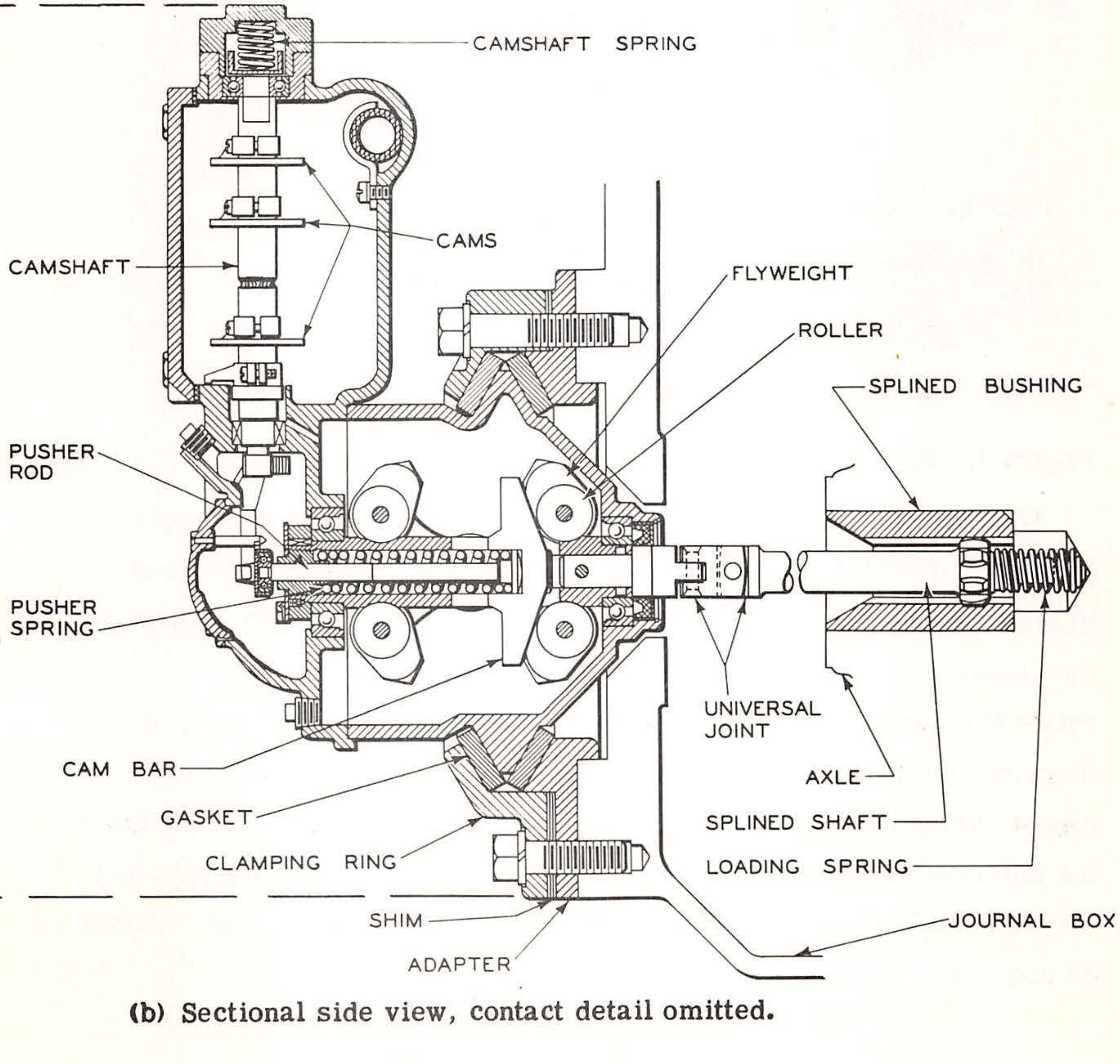

CONTACT
CAMSHAFT
CASE
OIL FILL PLUG
OIL DRAIN PLUG

(a) Front view, covers removed.

Figure 2. Journal box speed governor, 58400.


SECTOR
CENTRIFUGE
PINION

(d) Detail of centrifuge mechanism.


CAMSHAFT SPRING
CAMS
CAMSHAFT
FLYWEIGHT
ROLLER
SPLINED BUSHING
PUSHER ROD
PUSHER SPRING
UNIVERSAL JOINT
CAM BAR
AXLE
GASKET
SPLINED SHAFT
CLAMPING RING
LOADING SPRING
SHIM
JOURNAL BOX
ADAPTER

(b) Sectional side view, contact detail omitted.

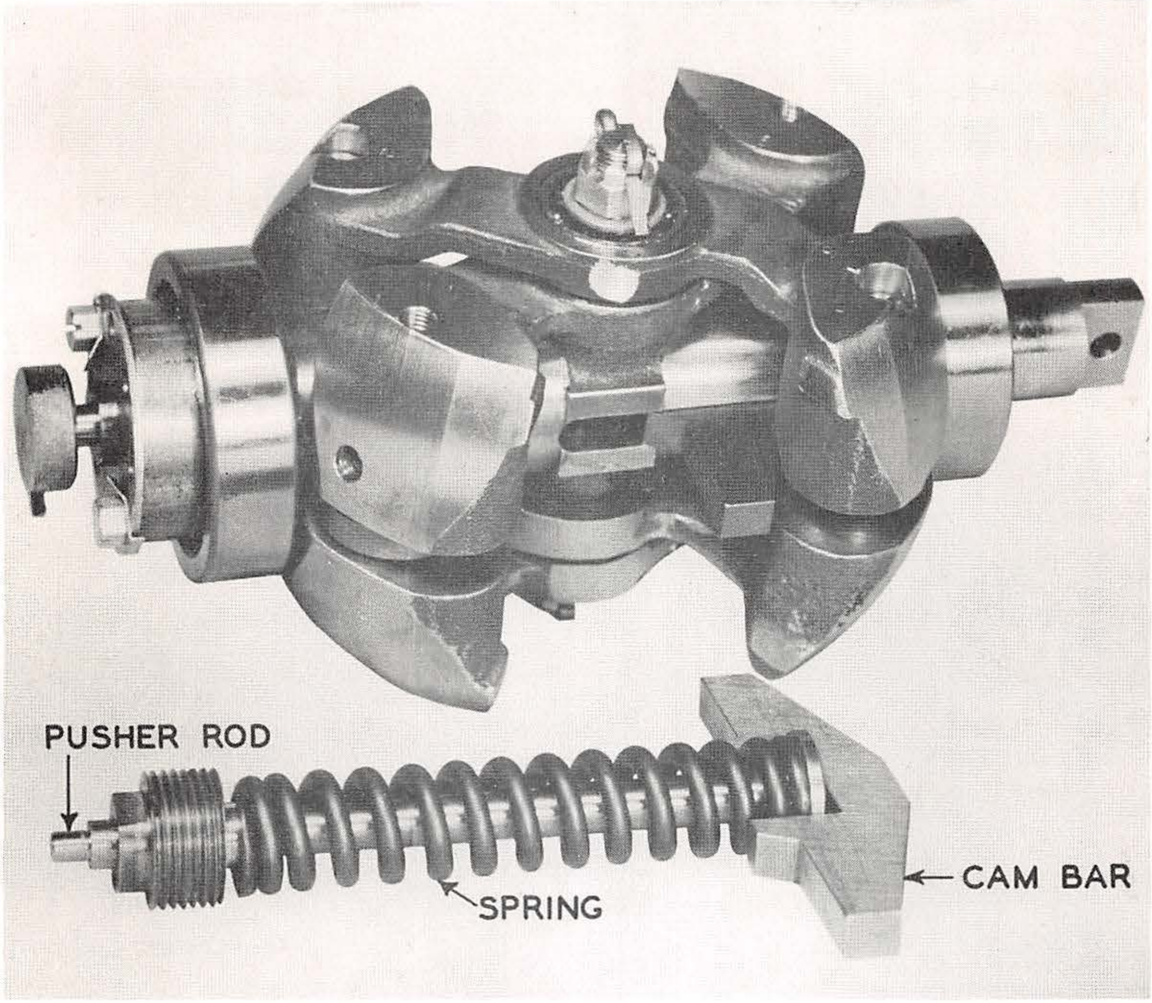


Figure 3. Scissors-type centrifuge.

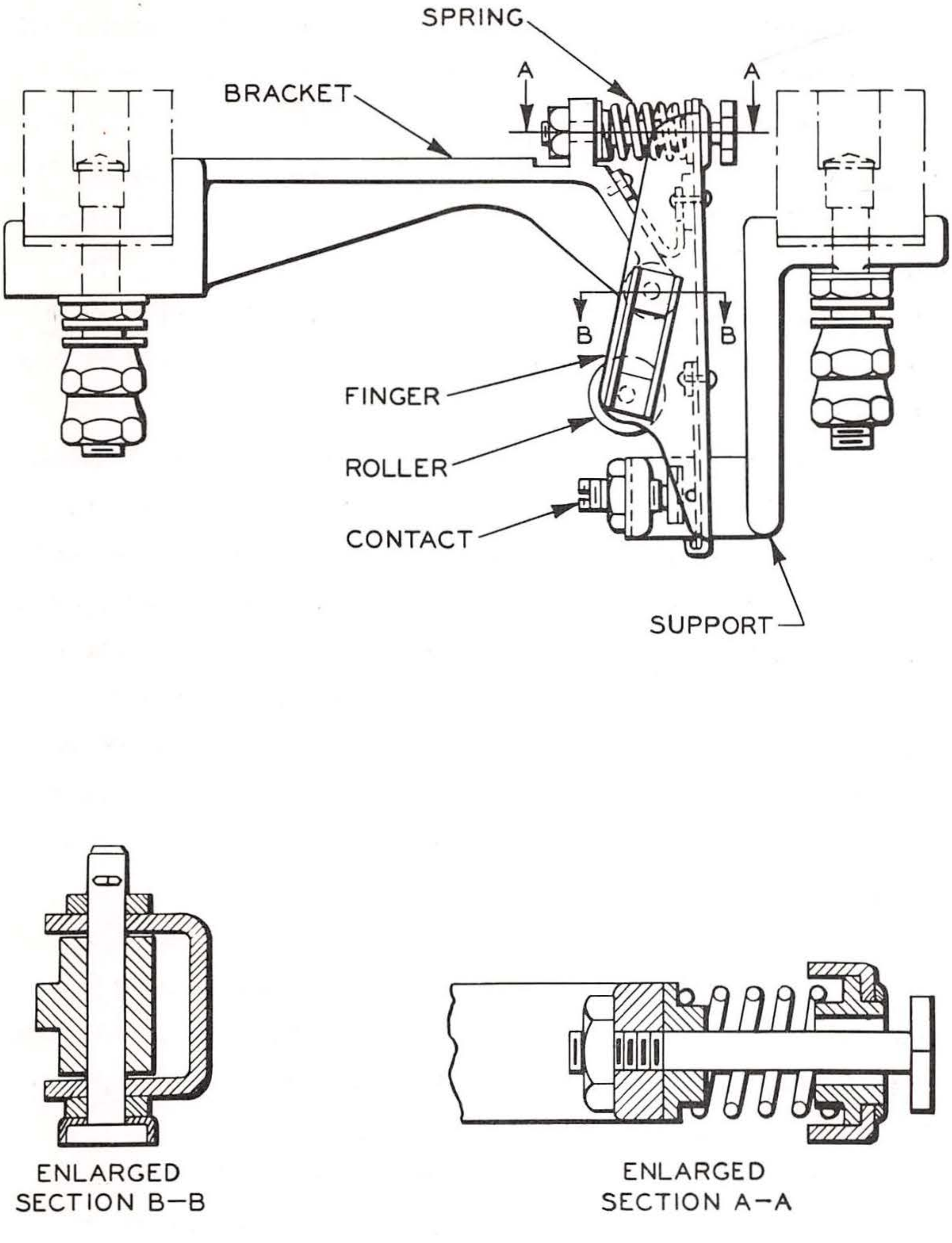
When the centrifuge weights swing outward with increasing speed, they cause the rollers to ride up the cam bar, forcing the pusher rod to the left. Since the left end of the pusher rod bears against an arm on the sector unit, the motion of the pusher rod causes the sector to rotate through an angle determined by the distance the pusher rod is displaced by fly-weight action. This is, in turn, a function of the angular velocity of the centrifuge. The sector rotation is transmitted to the pinion on the lower end of the camshaft, which results in rotation of the camshaft and attached cams, opening or closing the various contacts as required.

Resistance to the outward motion of the fly weights is supplied (1) by the light torsion spring at the top of the camshaft, acting back through the sector and pusher rod, and (2) by the heavy compression spring surrounding the pusher rod. For approximately the first 1/8 inch of pusher rod travel, the motion is opposed only by the camshaft spring, after which the pusher-rod spring also begins to act. This arrangement allows comparatively large camshaft rotation over the low-speed range without limiting high-speed range, thereby increasing low-speed sensitivity.

The governor is available with a maximum of five sets of contacts, as shown in Figure 2. One set of these is completely separate electrically from the others; the remaining four sets have one side internally connected through a common supporting bracket. Figures 4 and 5 show the details of the two types of contact construction. Figure 6 is a schematic diagram of the circuit arrangement used in the governor shown in Figure 2, and illustrates the utilization of the two types of contact units described above. Also shown is the circuit for a resistor-type heater unit incorporated in the governor to prevent frosting of contacts in cold weather.

Contacts are silver-to-silver, with capacity well in excess of normal control circuit requirements. Any set of contacts may be arranged for operation at any speed within range of the device (10 to 110 miles per hour with a 36-inch wheel) by choice of cams and adjustment of contact spacing.

The typical contact arrangement shown in Figure 6 was designed for use with a continuous inductive two-speed train control system. The tabulation of contact functions on page 41 gives an idea of the type of service to which the unit is adapted, and of the wide range over which contact action may be secured.


SPRING
A
A
BRACKET
B
B
FINGER
ROLLER
CONTACT
SUPPORT

ENLARGED SECTION B—B

ENLARGED SECTION A—A

Figure 4. Contact group with two contacts electrically separate.

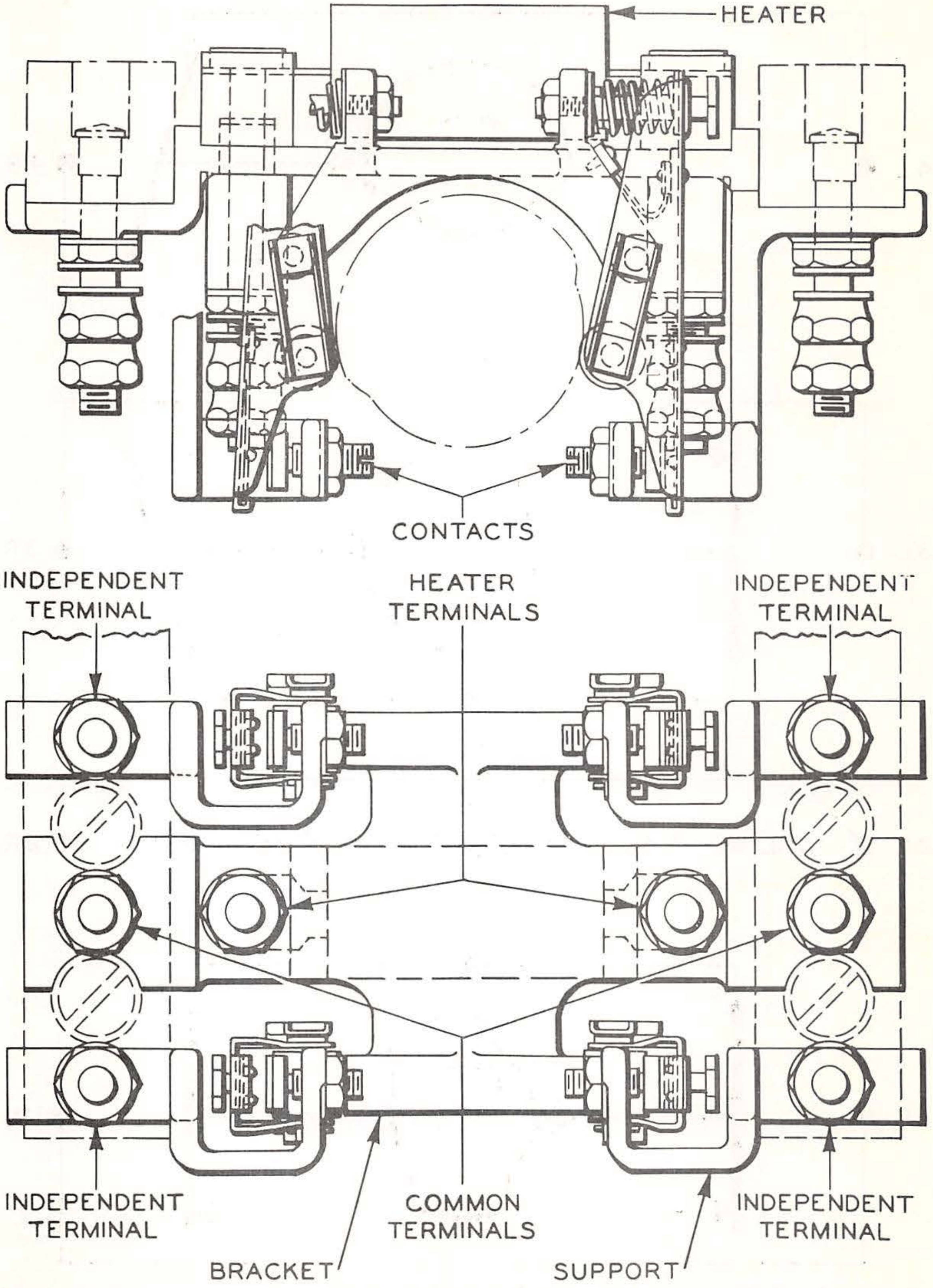

HEATER
CONTACTS
INDEPENDENT TERMINAL
HEATER TERMINALS
INDEPENDENT TERMINAL
INDEPENDENT TERMINAL
COMMON TERMINALS
INDEPENDENT TERMINAL
BRACKET
SUPPORT

Figure 5. Contact group with four contacts electrically separate and four contacts internally connected.

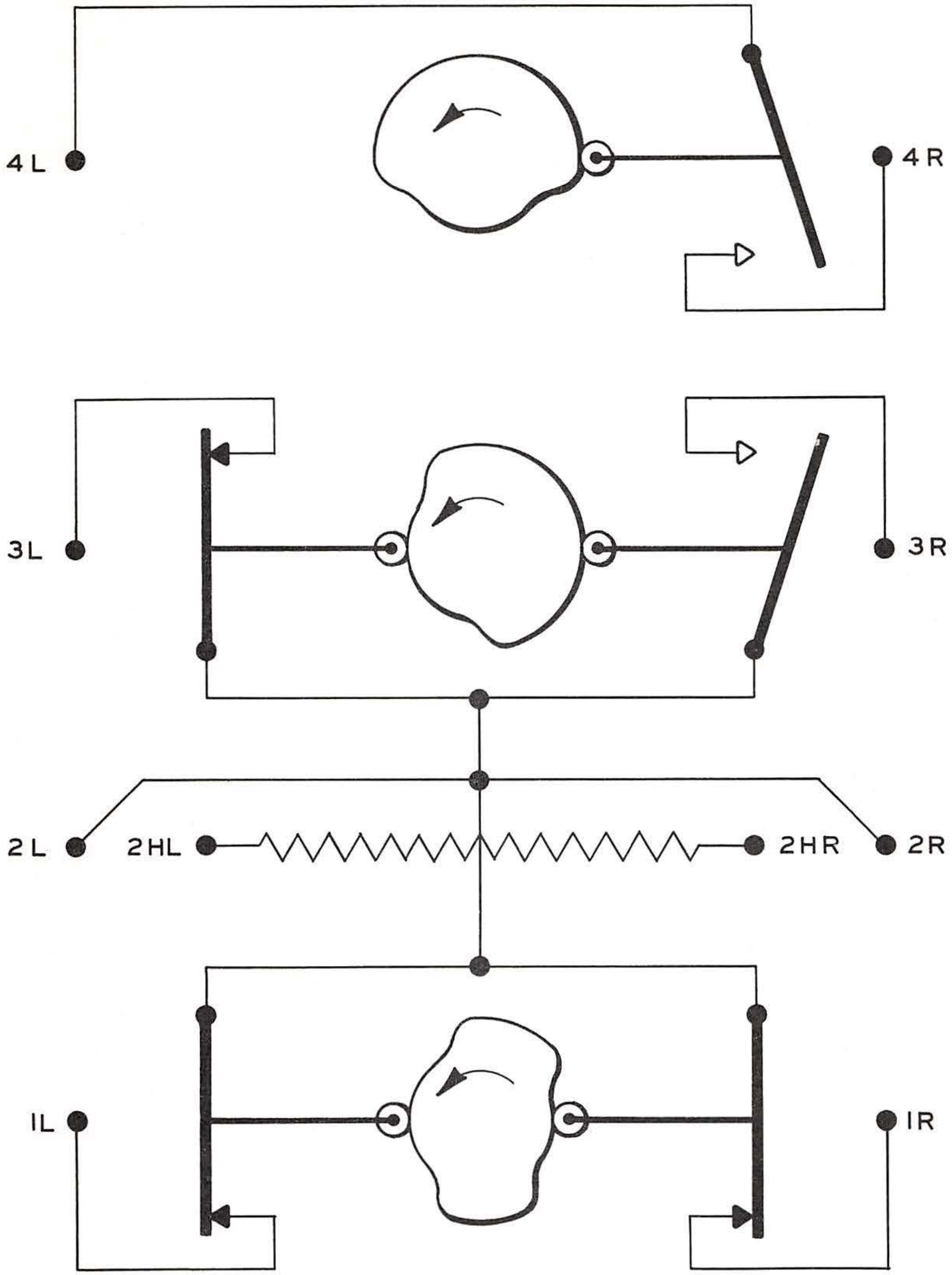

4L
4R
3L
3R
2L
2HL
2HR
2R
IL
IR

Figure 6. Schematic diagram for typical cam and contact arrangement used with continuous inductive two-speed train control (train standing still).

Contact No.	Function
4L - 4R	Opened below 10 miles per hour. Used to prevent train control reset until speed has been reduced sufficiently to guarantee that train will stop before brakes can be completely released.
3L - 2L (or 2R)	Opens at 23 miles per hour for freight, 30 miles per hour for passenger locomotives to initiate train control brake application when running over these speeds in restrictive zones.
3R - 2L (or 2R)	Closes at 20 miles per hour for freight, 27 miles per hour for passenger locomotives to sound speed warning whistle when running over these speeds in restrictive zones.
1L - 2L (or 2R)	Opens at 63 miles per hour for freight, 93 miles per hour for passenger locomotives to initiate service brake application when running over these speeds in clear zones.
1R - 2L (or 2R)	Closes at 33 miles per hour to permit preliminary brake release at that speed after entering restrictive zone at speed in excess of 33 miles per hour. Speed must be reduced to 23 miles per hour within 75 seconds of such release to avoid train brake application as determined by contacts 3L - 2L (or 2R). Used only on freight trains to avoid undesired stops which might occur if full service braking had to be held on a long train until speed was reduced to 23 miles per hour.

The governor may also be used as an overspeed control in conjunction with an intermittent inductive train control system. In such applications the governor operates through the train control system to give a service brake application whenever maximum speed is exceeded. Since the train

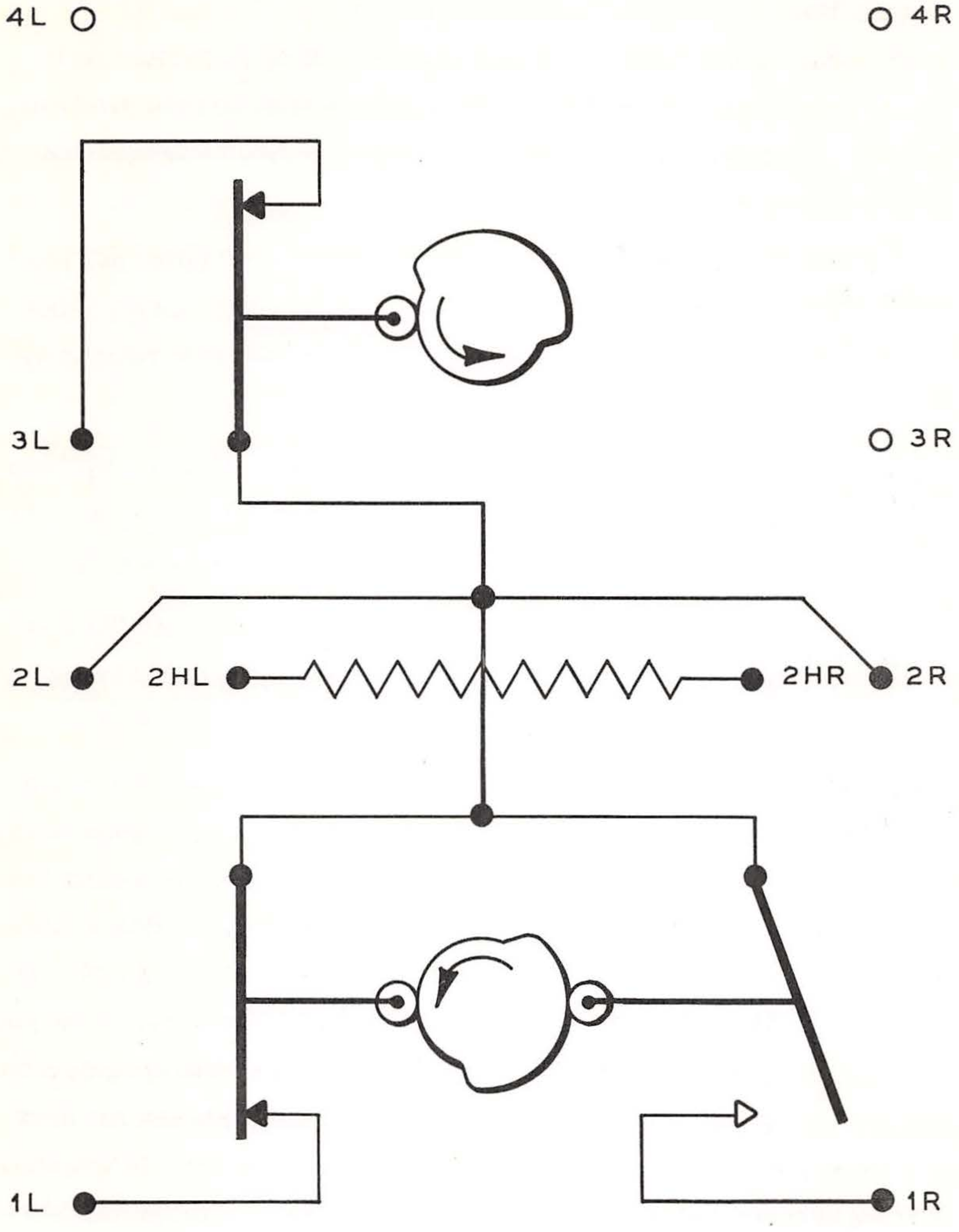

4L
4R
3L
3R
2L
2HL
2HR
2R
1L
1R

Figure 7. Schematic diagram for typical cam and contact arrangement used with intermittent inductive train control (train standing still).

control system is utilized for this purpose no duplication of brake application equipment is required to secure this result. In addition, the governor may be used to provide a low speed control which will ensure that the train is brought to a stop after a train control brake application before the system may be reset.

The photographs reproduced in Figure 1 are of an installation on an engine equipped with intermittent inductive train control.

A schematic diagram of a cam and contact arrangement for use with intermittent inductive train control is shown in Figure 7. It will be noted that only one contact group, similar to Figure 5, is used, and that only three of the four available contact positions are required. The following tabulation of contact functions will serve to explain the operation of the unit.

Contact No.	Function
3L - 2L (or 2R)	Closed below 10 miles per hour. Used to prevent train control reset until speed has been reduced sufficiently to guarantee that train will stop before brakes can be completely released.
1L - 2L (or 2R)	Opens at 95 miles per hour on passenger trains, 65 miles per hour on freight trains, to initiate service brake application.
1R - 2L (or 2R)	Closes at 92 miles per hour on passenger trains, 62 miles per hour on freight trains, to sound high speed warning whistle in engine cab.

Overall weight of the governor proper is approximately 56 pounds; adapter and clamping ring add 20 pounds additional to the unit as installed. Dimensions are such that when mounted on the journal box, the governor lies within normal clearance lines.

* * *

Biographies of the Month

This issue features the biographies of Messrs. Corcoran, Law, and Stilwell, who celebrate their birthdays this month. Also, to give you the information ahead of time, we are including the biographies of Messrs. Hartzell, Lorenzen, and Noble, who celebrate their birthdays in May.

John J. Corcoran, signal engineer, New York Central, with headquarters in Cleveland, Ohio, was born in West Springfield, Mass., April 14, 1889. He graduated from Worcester Polytechnic Institute in 1911 with a degree of Bachelor of Science in Electrical Engineering.

Mr. Corcoran entered railway service in 1906 on the Boston and Albany serving during the summer months of that year and the succeeding years to 1910 inclusive as water boy, track inspector, material clerk, and signal wireman's helper. In 1911 he entered the service of the New York Central at Buffalo, N. Y., serving successively as signal helper, assistant maintainer, maintainer, maintenance inspector, construction inspector, draftsman, general draftsman, assistant engineer, and chief inspector. From 1922 to 1924 he was engineer of construction and, from 1924 to 1937, assistant signal engineer, N.Y.C. Lines East. In September, 1937, he was appointed assistant signal engineer of the New York Central System, and on April 1, 1940, signal engineer, N.Y.C. Lines West of Buffalo, also including the Michigan Central and the C.C.C. & St. L.

Mr. Corcoran has served on various committees of the Signal Section, A.A.R. and in 1942 was Chairman. He is the author of several articles published in Railway Signaling.

Stanley W. Law, signal engineer, Northern Pacific, with headquarters in St. Paul, Minn., was born in Munson, Ohio, April 27, 1884. He graduated from Case School of Applied Science with a degree of Bachelor of Science in Electrical Engineering in 1906, and, in the same year, entered railway service as a signal apprentice until 1907. From 1907 to 1908 he was draftsman with the Illinois Central in Chicago. In 1908 he joined the C.M. & St. P., in Milwaukee, Wis., leaving in 1909 to join the C. & N. W. in Chicago as inspector and chief draftsman.

Mr. Law came with us in 1912 as foreman and assistant in our experimental laboratory. In 1913 he joined the Northern Pacific at St. Paul, Minn. as general signal inspector, advancing to electrical engineer of signals in 1916, valuation signal engineer in 1917 and assistant signal engineer in 1918. From May, 1918 to 1919 he served in the U. S. Army as 1st Lieutenant of Engineers. Upon his discharge in 1919, Mr. Law returned to the Northern Pacific as assistant signal engineer. He went to St. Paul College of Law for night school courses in 1925 and 1926. On May 1, 1932 he was appointed signal engineer.

Mr. Law has been active both in the Electrical Section and the Signal Section of the A.A.R., serving on several committees and as Chairman of the Signal Section in 1943.

Wilson H. Stilwell, signal engineer, Louisville and Nashville, with headquarters in Louisville, Ky., was born in Windsor, N. Y., April 9, 1885. He graduated from Syracuse University in 1910 with a degree of Bachelor of Science in Electrical Engineering.

Mr. Stilwell entered railway service in June, 1910, as assistant signal maintainer on the New York Central. In October of the same year he was promoted to signal maintainer. In 1912 he was signal inspector, and in 1914, signal draftsman, Grand Central Terminal. In April, 1914 he left the Central to become signal inspector on the Louisville and Nashville. In October of the same year he advanced to signal supervisor. In 1923 he was appointed assistant signal engineer, and from 1926 to 1928 he served as acting signal engineer. In 1928 he was promoted to signal engineer. Mr. Stilwell is a member of the A.I.E.E. and A.A.R. Signal Section.

William W. Hartzell, field engineer of signals, Boston and Maine, with headquarters in Boston, Mass., was born in Bethlehem, Pa., May 28, 1908. After completing his high school education, he attended the Bethlehem Business College, and entered railway service with the Lehigh Valley as a signal helper during summer vacations from school. Upon completion of his school work in May, 1926, he stayed with the Lehigh Valley and was promoted successively to assistant signalman, signalman and maintainer. He worked nine months for the New York Central and then returned to the Lehigh Valley.

With the exception of another nine-month period in 1934-35, spent as circuit engineer with the Boston and Maine, Mr. Hartzell served from December, 1929, to January, 1940, as a circuit engineer in our commercial engineering department and with our London company, spending four years in Brazil on a large signaling project on the Central Railroad of Brazil. He returned to the employ of the Boston and Maine in January, 1940, as circuit engineer, and was promoted in February, 1944, to field engineer of signals.

Harry C. Lorenzen, signal engineer and superintendent of telegraph, with headquarters in Detroit, Michigan, was born May 9, 1883, in Detroit. After graduating from the Detroit public schools and the Detroit Institute of Technology, he entered railway service with the Michigan Central as a signal helper in August, 1902, and during the next three years was employed as a signal fitter and wireman on signal construction work. From June, 1905 to April, 1906, he was a signal maintainer on the New York City subways, which position he resigned to enter the service of the New York Central as a signal inspector on construction in the electrified zone. In August, 1907, he returned to the Michigan Central and was employed as a signal foreman in the construction and maintenance of electric interlockings. In February, 1910, he again returned to the New York Central, in Albany, and for five years held the several positions of circuit designer, signal inspector, circuit engineer, office engineer, and construction engineer.

Mr. Lorenzen left the New York Central in October, 1916, to become assistant engineer in the signal department of the Pere Marquette. He was promoted to assistant signal engineer on April 1, 1923, and to signal engineer and superintendent of telegraph on January 1, 1942.

Stanley E. Noble, superintendent telegraph and signals, Chicago and Northwestern, with headquarters in Chicago, was born in West Pittston, Pa. May 22, 1888. After graduation from Pennsylvania State College in 1915, he entered railroad service in June of that year with the D.L. and W., and was engaged in signal and electrical construction work. In September, 1917, he joined the C. and N.W. as circuit draftsman. From May to December, 1918, he was in the U. S. Army, Training Cadre, Camp Lee, Va., and in the Artillery Officers' Training School, Camp Taylor, Ky. He returned to the C. and N.W. as circuit draftsman and in April, 1922, was promoted to chief draftsman.

Mr. Noble was appointed assistant engineer, signal department, in July, 1924, advancing to general signal inspector in November, 1926, assistant signal engineer in January, 1928, and signal engineer in October, 1937. In November, 1939, he was promoted to superintendent of telegraph and signals.

Mr. Noble has been active in the A.A.R. Engineering Division, Signal Section; and the Operating Division, Telegraph and Telephone Section. He was Chairman of the Signal Section in 1945. He is a member of the Western Railway Club and author of several articles which have appeared in Railway Signaling.

* * *

G-R-S NEWS
March 1946

Model 9 Hand-Operated Switch Machine

To meet the need for a hand-operated switch machine with integral locking suitable for main line installation, the new G-R-S Model 9 hand-operated switch machine has been designed. The following information has been prepared and reproduced in this issue of the News as advanced information on this new device. This information will be published later in the form of a development sheet.

If you have any comments or additions, will you kindly send them in to the Advertising Department within the next week or two, so that they can be included in the development sheet before it is printed.

— * —

I. GENERAL DESCRIPTION

The Model 9 machine is capable of handling the heaviest rail used on main lines without requiring excessive effort on the part of the operator, and furnishes the positive facing point protection and signal circuit control usually associated with power-operated machines.

The Model 9 machine promotes safety, facilitates switch operation, and provides, in a single type, a unit readily adaptable to most switch layouts, including turnouts, crossovers, and switch and derail installations.

The basic Model 9 hand-operated switch machine provides switch throw operation with normal position locking, but provision is made for supplementary features as may be specified. Some of the combinations possible are listed below. Others are available.

1. Normal locking, normal circuit controller, normal point detector.

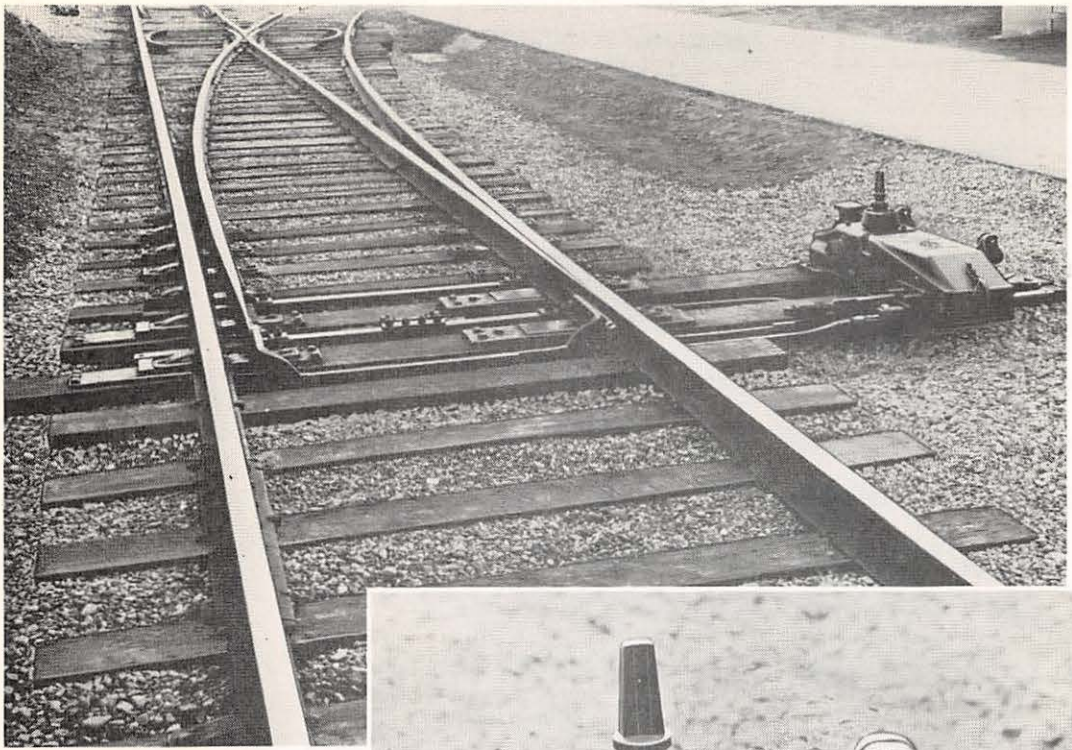


Figure 1. Model 9 hand-operated switch machine layout.

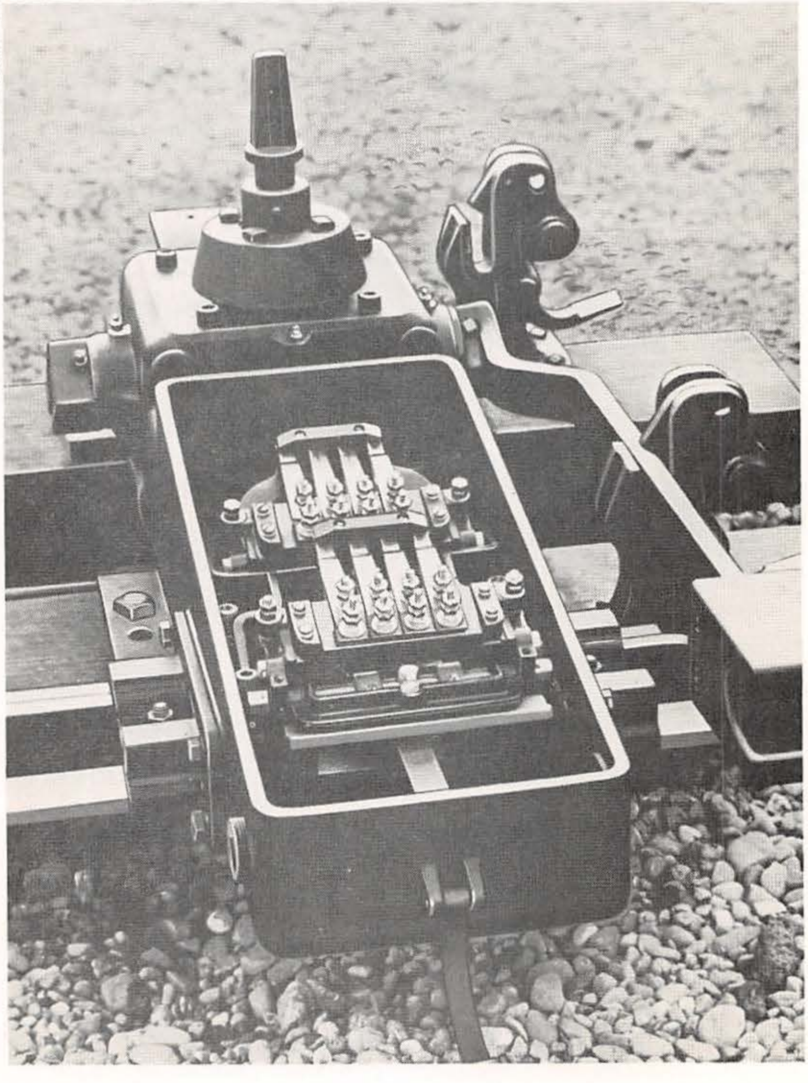


Figure 2. Weatherproof cover removed from machine, showing normal and reverse circuit controllers.

2. Normal and reverse locking, normal and reverse circuit controllers, normal and reverse point detectors.
3. Normal position, separately controlled locking, normal and reverse circuit controllers, normal and reverse point detectors.

In addition, machines will be supplied, as required (a) without provision for target staff, or (b) equipped with target staff and lamp tip specified by customer. Machines will also be available with the G-R-S Model 9 electric switch lock built in as an integral component.

The Model 9 hand-operated switch machine is ruggedly built. In addition, particular care has been taken in the design to simplify field installation and maintenance problems by providing accessible adjustment devices and conveniently located lubrication points. As a result, the machines are readily installed and maintained.

Some of the features of the Model 9 machine that deserve particular emphasis are:

1. Machine will handle heaviest rail without requiring excessive effort by operator.
2. Machines are available to provide normal locking only, or both normal and reverse locking.
3. Mechanism provides high mechanical advantage, particularly at ends of hand-throw lever travel, making switch operation easier.
4. Escapement crank type of drive is irreversible at ends of stroke, thus locking switch through the throw rod as well as the lock rod.
5. Circuit controllers are located so that all contacts are easily accessible.
6. Double-locking types cannot complete hand-throw stroke unless switch points have moved into correspondence with the position

to which hand-throw lever has been thrown. Completion of hand-throw lever stroke, with corresponding actuation of the circuit controllers, gives positive indication of "over-and-locked" position. Single-locking types provide similar protection, but for the normal position only.

7. On machines equipped with normal point detectors, any forced movement of points from the normal locked position (such as from an improper trailing movement) results in a "latched-in" restrictive circuit controller position, retained even if points return to normal, insuring inspection of switch and machine after such occurrence.
8. Single-locking machines may be used for either right- or left-hand layouts with either point open, by simple rearrangement of assembly. Double-locking machines may be changed to opposite hand by substituting proper lock-rod assembly and rearranging other components.
9. Through use of heavy-duty bearings on throw-crank shaft, use of an outboard lower bearing beneath the throw crank has been avoided.
10. Model 9 and Model 10 electric switch locks are easily applied to machine where required. The Model 9 lock mounts directly on the switch machine housing, and becomes an integral part of the installation. Machines will be supplied, where required, with factory-installed Model 9 locks.
11. Accessible, easily operated, permanent setting, adjustment devices are provided, wherever required, to facilitate setting up machine for proper operation.
12. Machine will operate switches requiring up to 6-inch throw.
13. Low, compact design with rugged housing and weatherproof covering provides maximum protection from dragging equipment,

spillage from passing trains, action of elements, etc.

14. Machine requires only two long ties for mounting. No framing required on these.
15. Long stroke of locking plunger (8-7/8 inches) provides ample motion for operation of auxiliary equipment.

Figures 1, 2, and 3 show three photographs of an experimental installation made on the yard tracks at Rochester. The close-ups of the machine with weatherproof cover removed, give a good idea of the design, of the ruggedness built into the unit, and of the accessibility of internal parts. The layout photograph shows general installation appearance.

More detailed information on layout and outline dimensions is given in Figure 5, which is a drawing for a typical right-hand layout, right-hand point normally closed, using a normal locking machine with point detector. Dimensions and outline shown are subject to slight change because of design refinement current at time of writing.

The complete machine, including hand-throw lever latch stands, (but not including electric switch lock), weighs approximately 500 pounds.

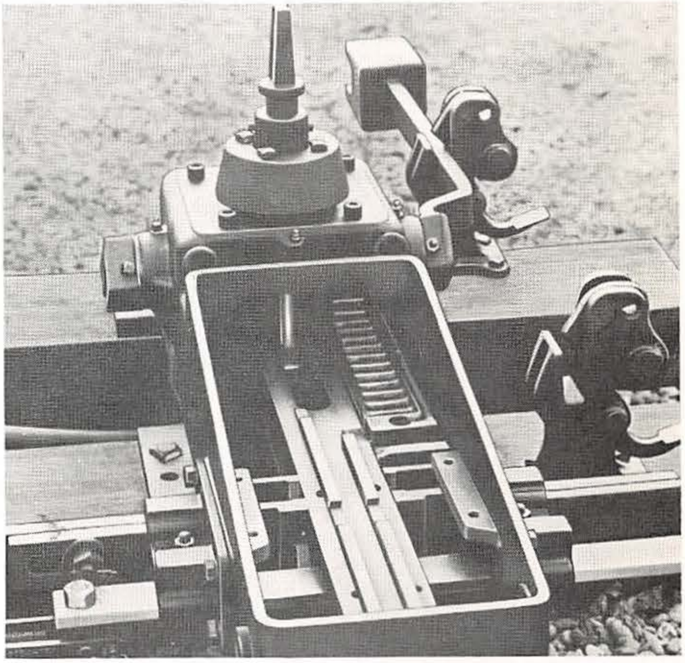


Figure 3. Circuit controllers removed, exposing the mechanism.

II. DESCRIPTION OF OPERATION

The operation of the G-R-S Model 9 hand-operated switch machine may best be described by considering separately the functions performed by the mechanism. The description that follows covers the operation of a machine equipped for normal and reverse locking, normal and reverse circuit control, and normal and reverse point detection.

The operations performed by the Model 9 machine can be broken down as follows:

1. Movement of switch points.
2. Locking of switch points - normal and reverse.
3. Operation of circuit controllers - normal and reverse.
4. Operation of point detectors - normal and reverse.

In order to avoid the confusion that would arise from trying to cover all types of layout in one description, this discussion will be confined to a machine located in a right-hand layout with left-hand point normally open. The layout is sketched in Figure 4, with auxiliary arrows indicating the sense of directions used in describing operation.

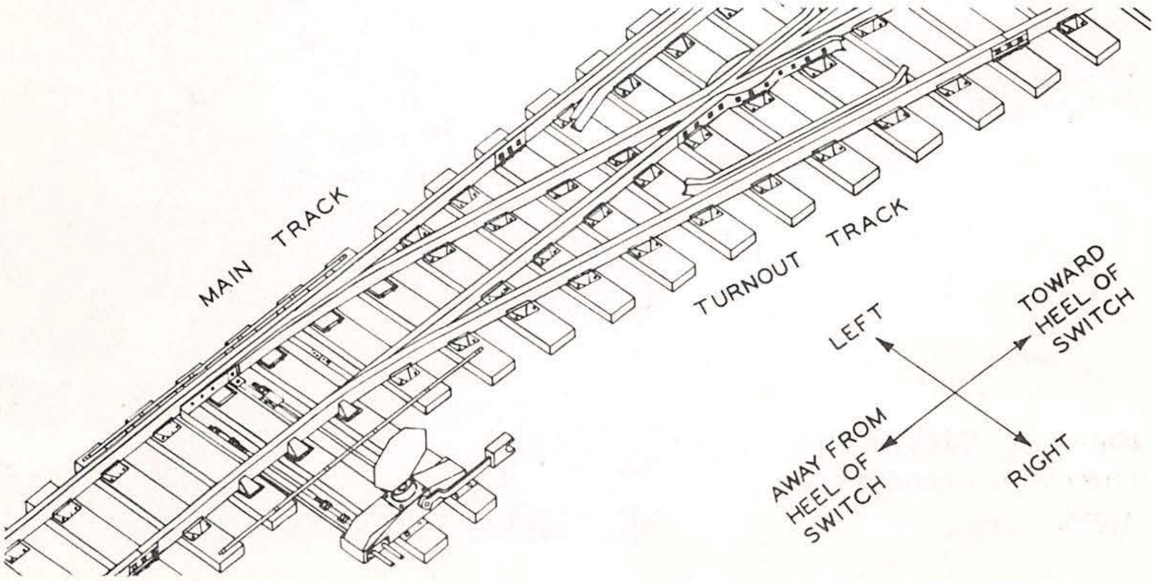
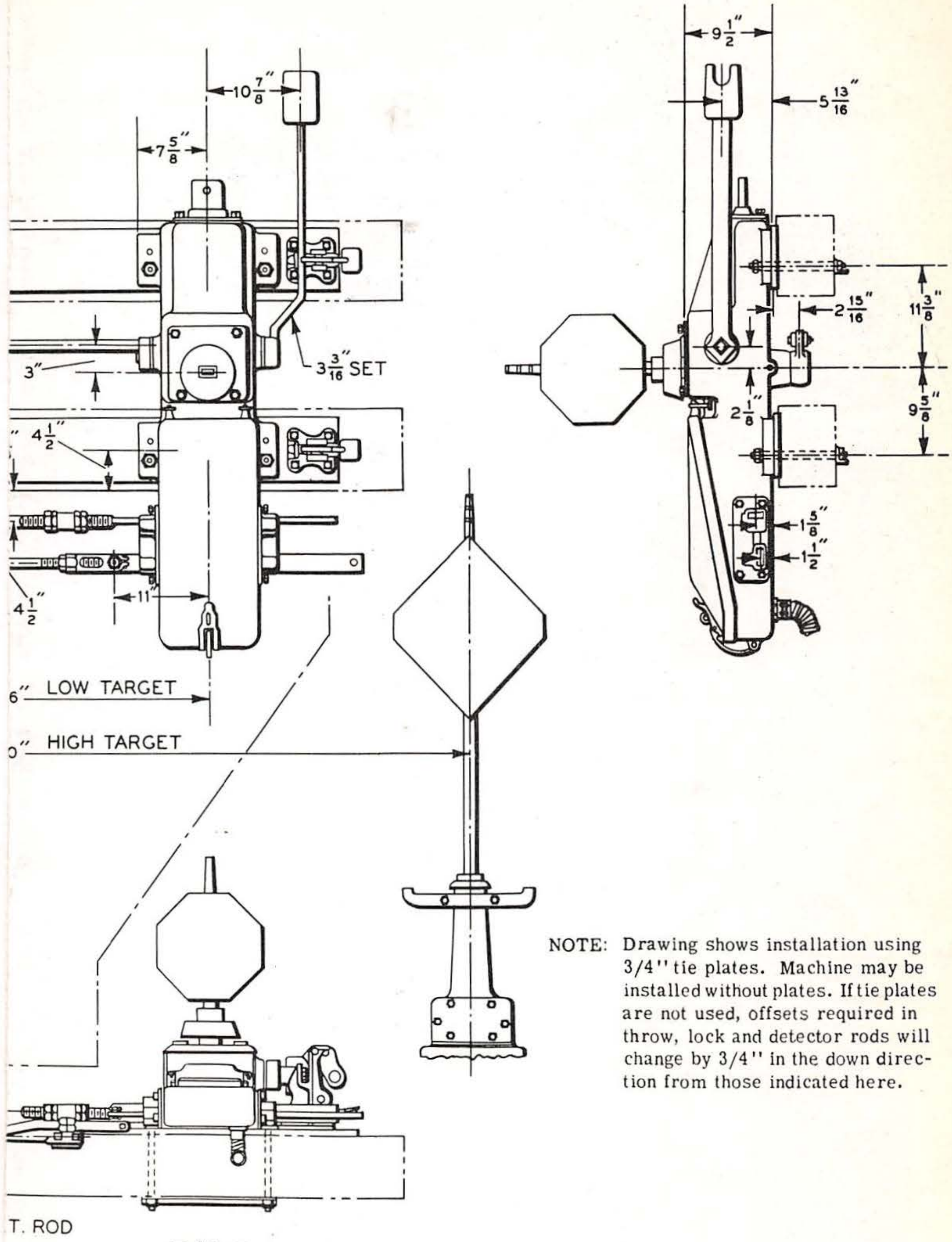


Figure 4. Schematic layout for machine described in text, indicating sense of directions used in the description.


10 7/8"
7 5/8"
9 1/2"
5 13/16"
3 3/16" SET
3"
4 1/2"
2 15/16"
11 3/8"
9 5/8"
2 1/8"
1 5/8"
1 1/2"
4 1/2"
11"
LOW TARGET
HIGH TARGET
T. ROD
SET
3"

NOTE: Drawing shows installation using 3/4" tie plates. Machine may be installed without plates. If tie plates are not used, offsets required in throw, lock and detector rods will change by 3/4" in the down direction from those indicated here.

Figure 5. Typical layout for G-R-S Model 9 hand-operated switch machine, right-hand layout, right-hand switch point normally closed.

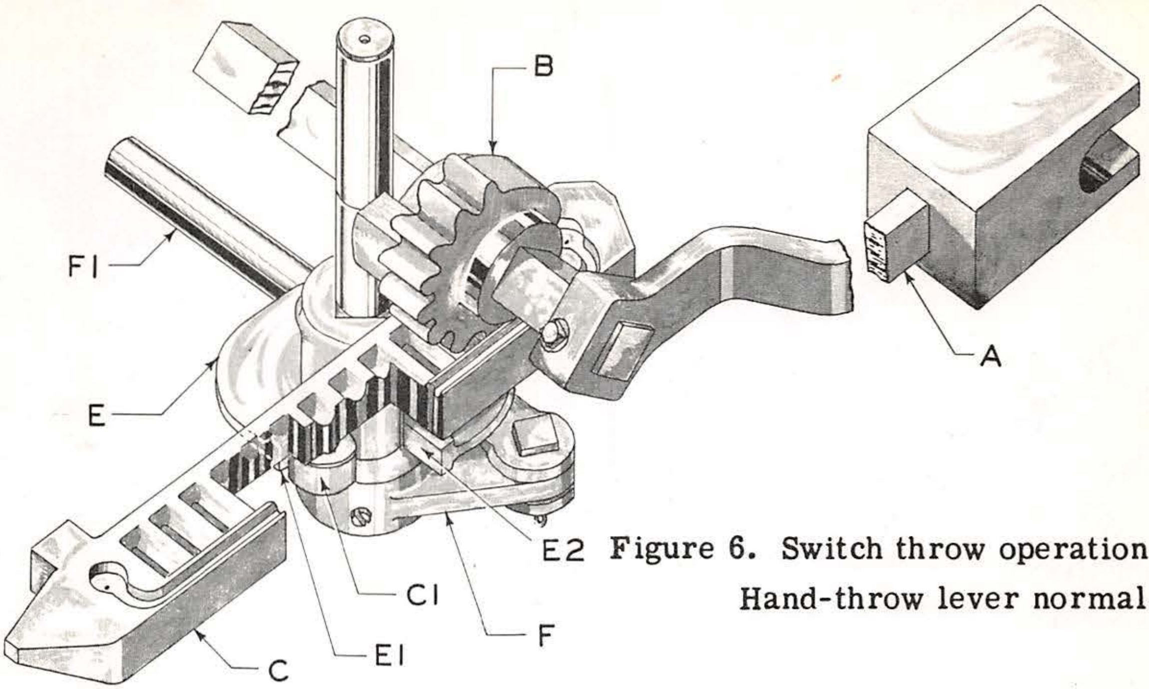


Figure 6. Switch throw operation.
Hand-throw lever normal.

It should be noted that details of appearance of machine components, as shown in the illustrations, have been taken from an experimental prototype, and may be changed somewhat in production units. Operating principles, however, will remain essentially as described.

1. Movement of Switch Points

Lifting hand-throw lever (A) from its normal position (Figure 6) and moving it toward reverse causes sector (B) to rotate. Rotation of sector (B) drives rack (C) toward the heel of the switch. Mounted on the bottom of rack (C) is roller (C1) which moves along surface (E1) of escapement crank (E). Since surface (E1) is parallel to the direction of movement of roller (C1) at this stage of operation, escapement crank (E) is not affected by motion of roller (C1).

Further motion of rack (C) carries roller (C1) off surface (E1), across the jaw of escapement crank (E) and into contact with the opposite side of the jaw, (Figure 7). This occurs when hand-throw lever (A) has moved about 34 degrees from the normal position.

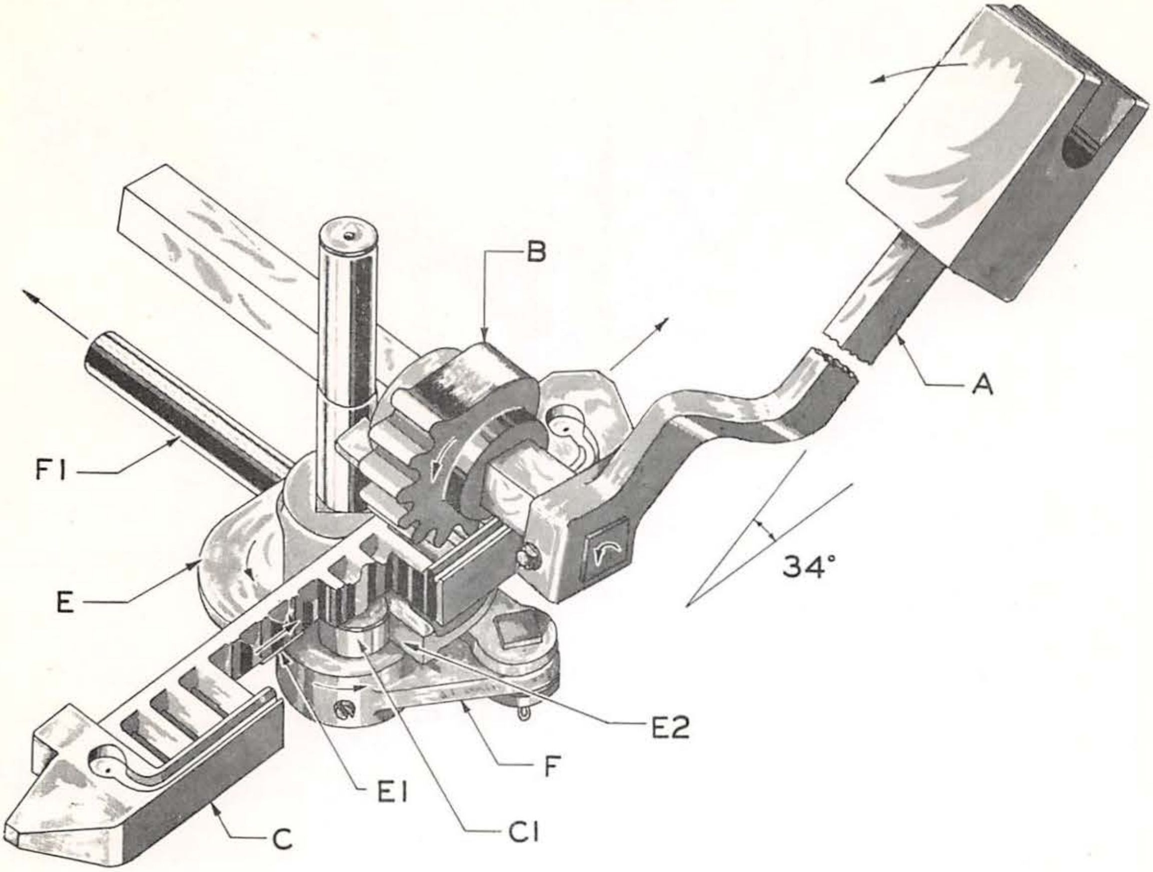


Figure 7. Switch throw operation. Hand-throw lever 34 degrees from normal.

Continued motion by rack (C) and roller (C1) now causes escapement crank (E) to rotate as indicated in Figure 7. Roller (C1) drives escapement crank (E) until the latter has turned 90 degrees, at which time surface (E2) lines up with the direction of travel of roller (C1). This occurs when hand-throw lever (A) has moved approximately 155 degrees from the normal position. Thereafter, roller (C1) moves along surface (E2) without causing further rotation of escapement crank (E) until hand-throw lever (A) has been carried over completely to the reverse position, (Figure 8).

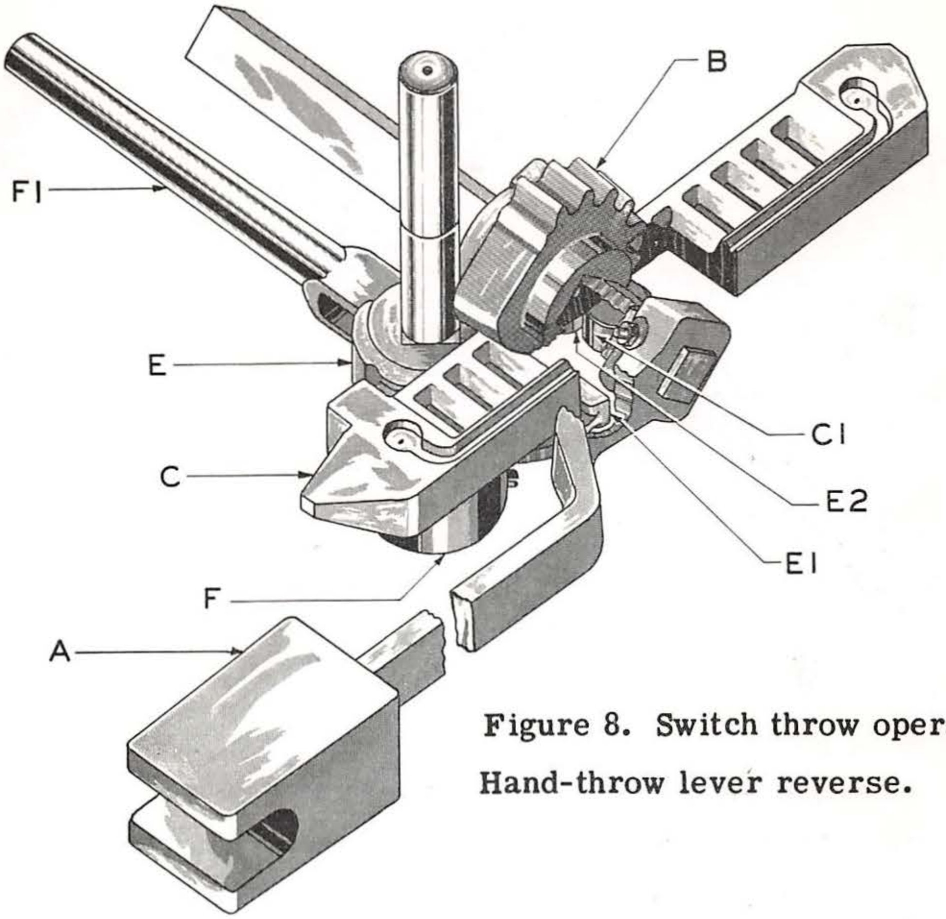


Figure 8. Switch throw operation. Hand-throw lever reverse.

Rotating on the same shaft with escapement crank (E) is throw crank (F) (Figures 6, 7, and 8). The 90-degree rotation of escapement crank (E) described above causes similar rotation of throw crank (F), which, transmitted as linear motion through throw rod (F1), moves the switch points to reverse position.

It should be noted that once roller (C1) has moved onto either surface (E1) or (E2), and roller (C1) has driven either surface to the position parallel to its line of travel, the switch is effectively locked, since the mechanism is irreversible in these positions.

Return of hand-throw lever (A) to the normal position reverses the above actions, and returns the switch to normal.

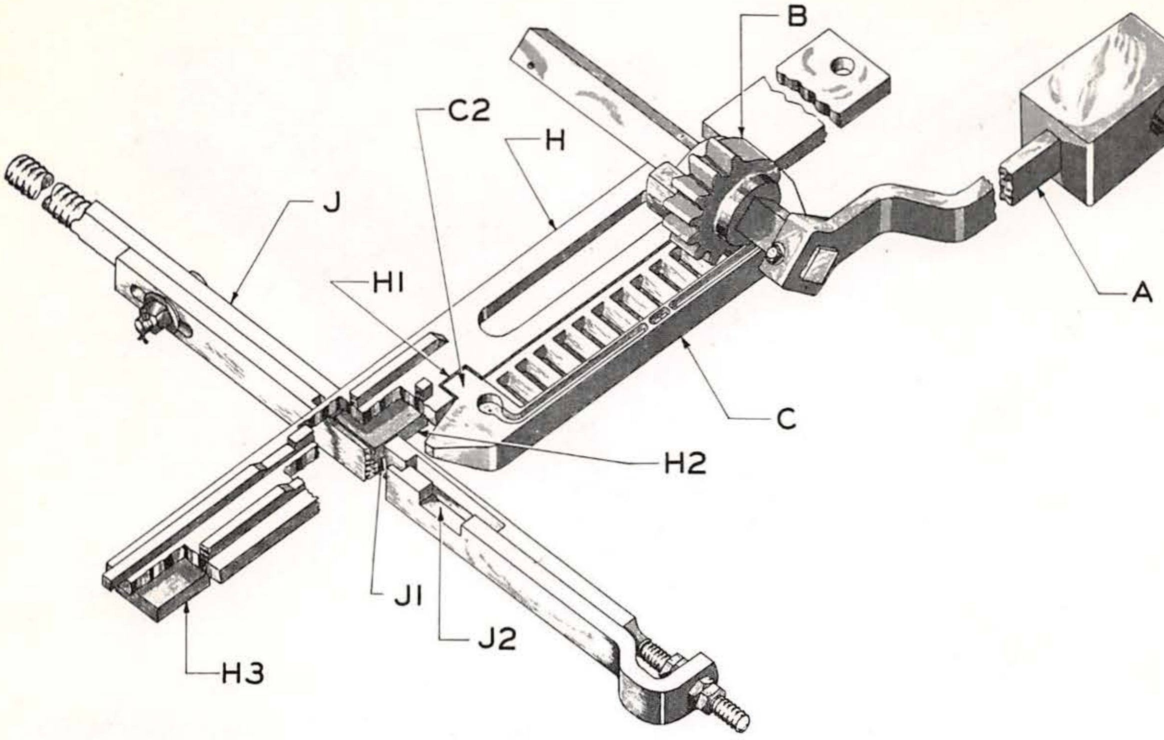


Figure 9. Switch locking operation. Hand-throw lever normal.

2. Locking of Switch

(a) Integral Locking

With hand-throw lever (A) in its normal position, (Figure 9), rack (C) is in its extreme position away from the heel of the switch. In moving to this position, rack (C) carries locking plunger (H) also to its extreme position away from the heel of the switch by means of ear (C2) and notch (H1). In this position, block (H2) is in notch (J1) on lock rod assembly (J), locking lock rod assembly (J) in place. Since lock rod (J) is rigidly coupled to the switch points, the switch is therefore locked normal.

As hand-throw lever (A) is thrown over to reverse (Figure 10), sector (B) drives rack (C) toward the heel of the switch. This motion is transferred to locking plunger (H) by ear (C2) and notch (H1). With locking plunger (H)

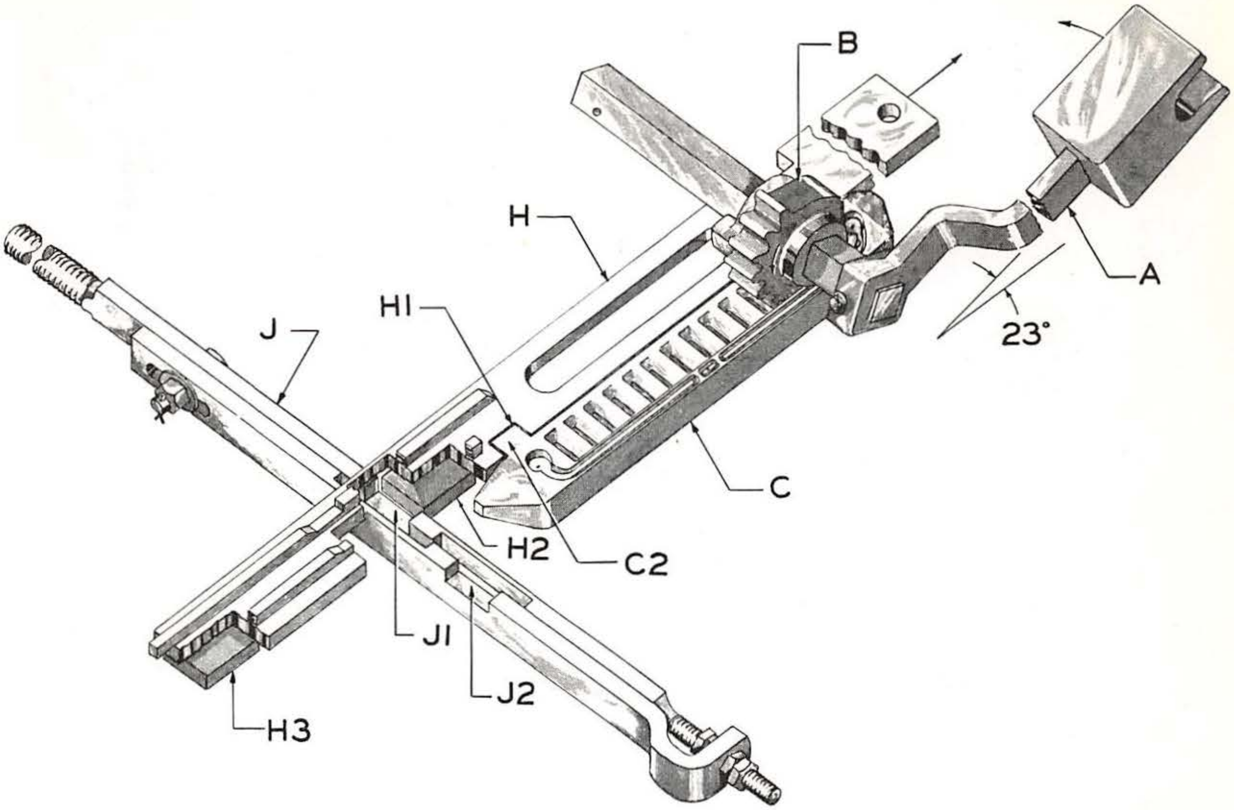


Figure 10. Switch locking operation. Hand-throw lever 23 degrees from normal.

moving as described, block (H2) moves out of notch (J1), unlocking the switch. This occurs after approximately 23 degrees of travel by hand-throw lever (A).

Since the switch points do not begin to move until hand-throw lever (A) has travelled 34 degrees from normal (see on page 10 under "Movement of Switch Points"), there are 11 degrees of travel by hand-throw lever (A) between the point of unlocking and beginning of switch movement. This insures that block (H2) is well clear of notch (J1) before switch reversal begins.

As previously mentioned, switch reversal movement is complete when hand-throw lever (A) reaches 155 degrees

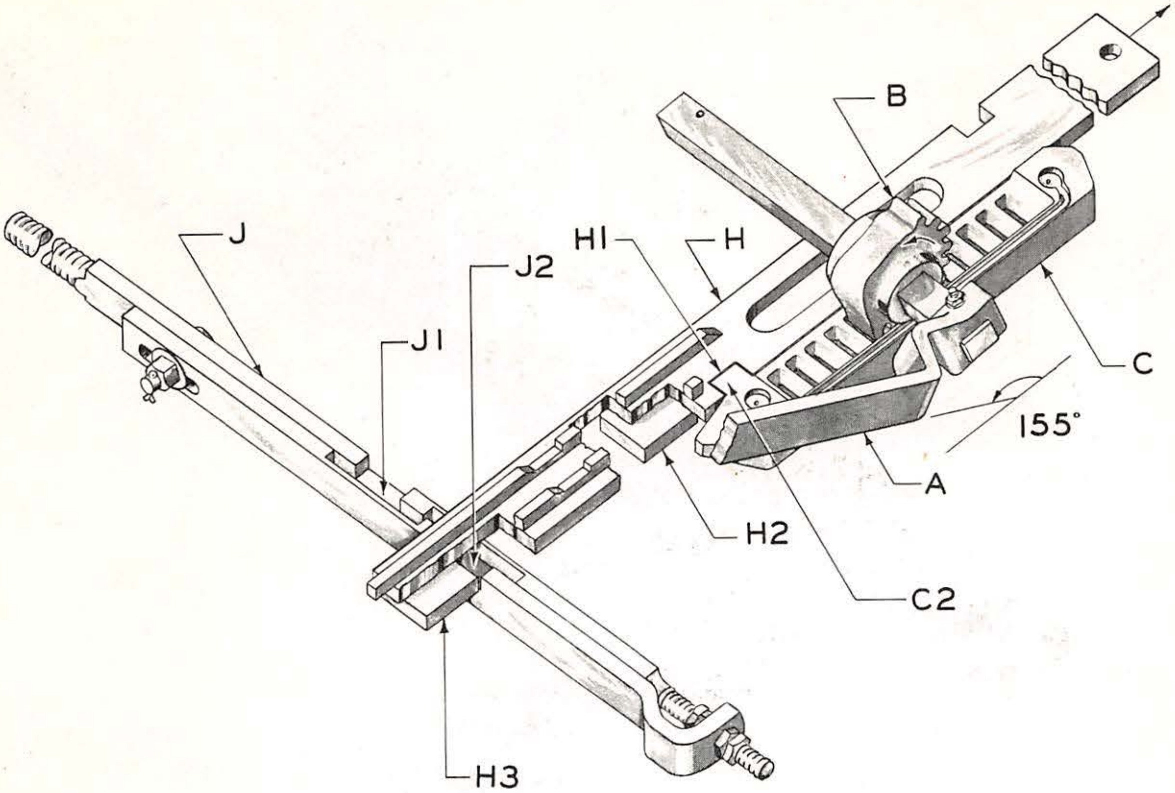


Figure 11. Switch locking operation. Hand-throw lever 155 degrees from normal.

from normal. During the period between 34 degrees and 155 degrees, lock rod assembly (J), being coupled to the switch points, moves to the left, Figure 11. This results in the movement of notch (J2) into position under locking plunger (H) when hand-throw lever (A) reaches the 155-degree position. As hand-throw lever (A) moves beyond the 155-degree point, locking plunger (H) continues to move toward the heel of the switch and block (H3) enters notch (J2). This action begins when hand-throw lever (A) is at 157 degrees, and continues for the remaining 23 degrees of travel of hand-throw lever (A), completing the reverse locking of the switch, Figure 12.

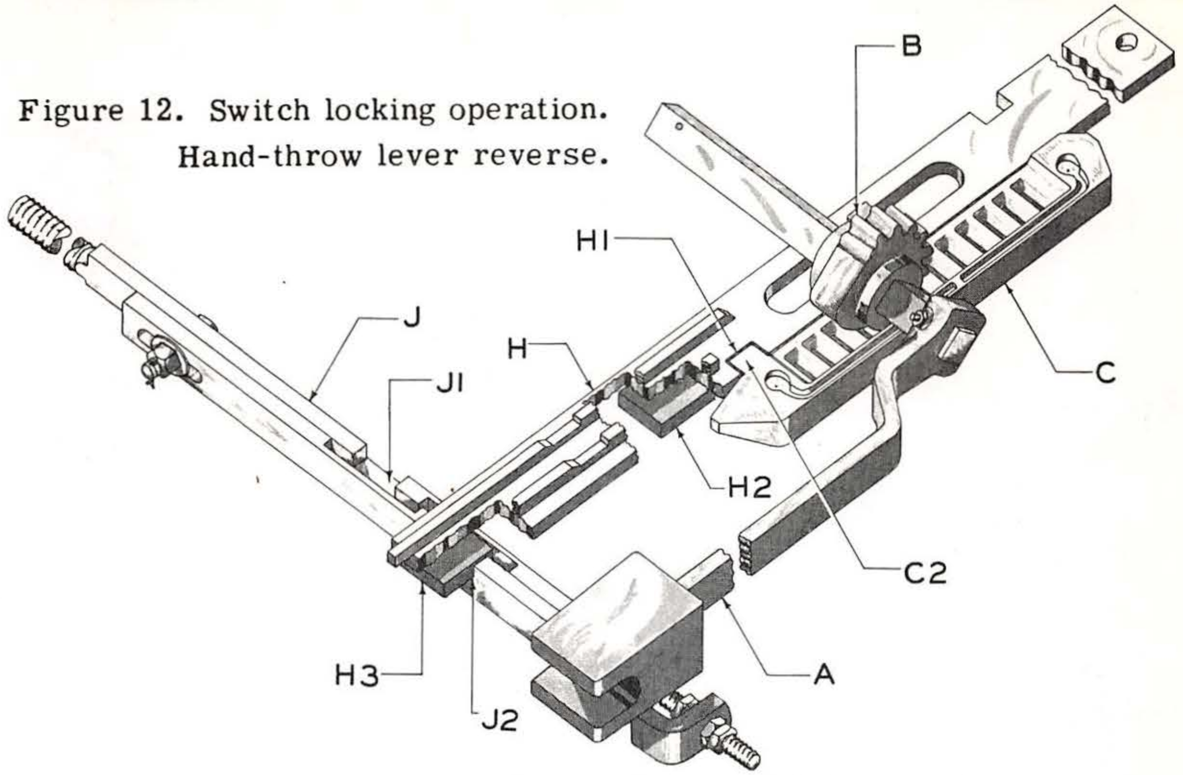


Figure 12. Switch locking operation. Hand-throw lever reverse.

An important feature to be noted in connection with the locking action is that notches (J1) and (J2) are so designed that normal locking block (H2) cannot enter reverse locking notch (J2), or reverse locking block (H3) enter normal locking notch (J1). It is not possible, therefore, to complete the stroke of the locking plunger on a double-locking machine unless the points have moved into the correct position.

(b) Separately Controlled Locking

Separately controlled locking is used in this discussion to refer to the type of locking mechanism on the Model 9 machine in which the locking action is controlled from a remote point by mechanical connection. A switch machine so equipped may be described as a "dependent" machine, since it cannot be operated independently of a previous unlocking operation at another point.

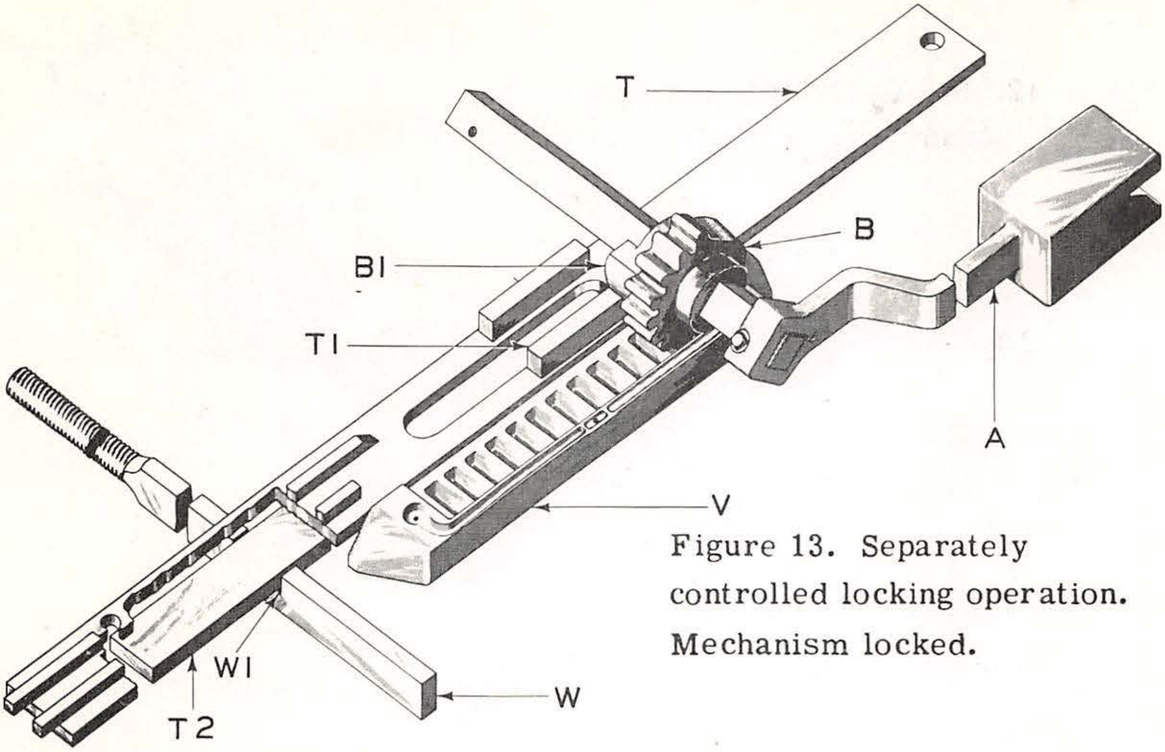


Figure 13. Separately controlled locking operation. Mechanism locked.

Separately controlled locking is applicable only to single-locking (normal) machines, and cannot be used with the typical double-locking machine being described in this discussion. However, because of the special features involved, a brief description of the operation of separately controlled locking machines will be of interest.

When separate locking control is used, a different design of locking plunger and a different rack are used instead of those required for single integral locking. Other parts remain the same as in the integral locking machine.

In a separately controlled locking machine, locking plunger (T), Figure 13, is not driven by rack (V), but is actuated from a remote control point, usually by pipe connection. The mechanism is designed to prevent throwing hand-throw lever (A) until action from the remote lo-

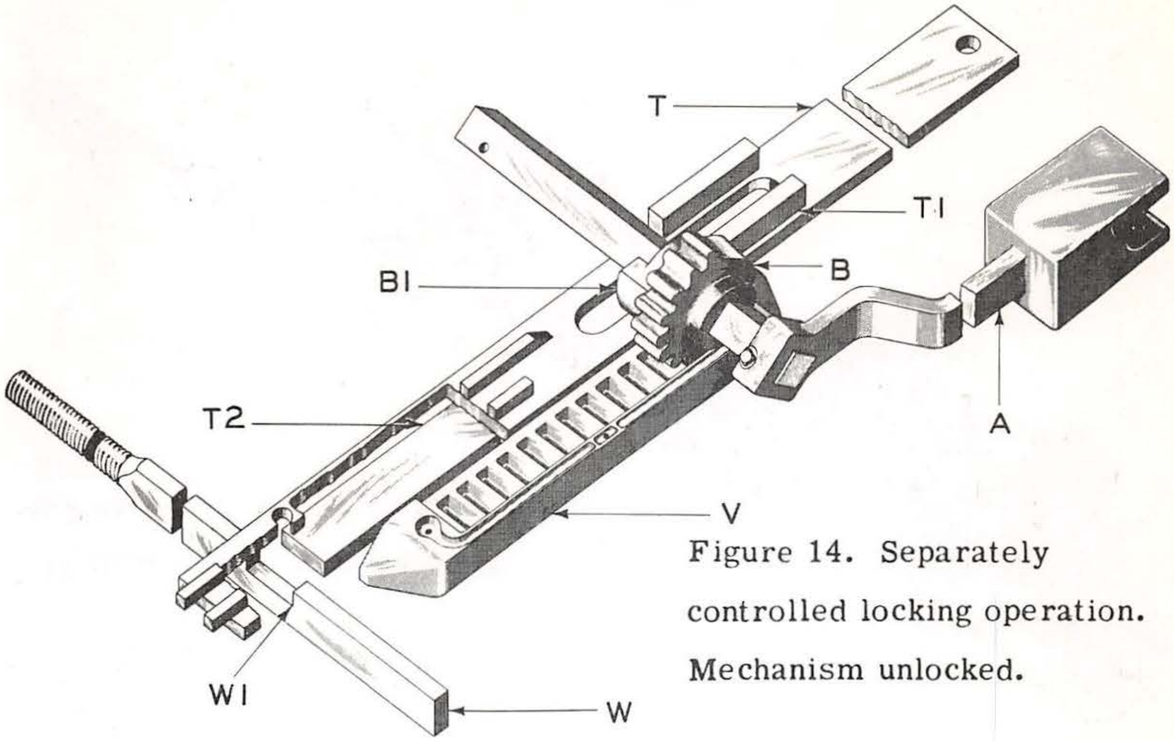


Figure 14. Separately controlled locking operation. Mechanism unlocked.

cation has unlocked the switch. This is accomplished by dog (T1) on locking plunger (T), which engages lug (B1) on sector (B). Sector (B) is therefore unable to rotate until locking plunger (T) has moved sufficiently toward the heel of the switch to withdraw locking block (T2) from notch (W1) on lock rod (W), Figure 14.

Locking block (T2) is several inches longer than the block used on an integral locking machine. The extra length is required to furnish positive locking protection in view of the lost motion, lack of rigidity, etc., frequently found in pipe connections.

Switch throw mechanism, circuit controller action and point detection are the same on separately controlled as on integral locking machines.

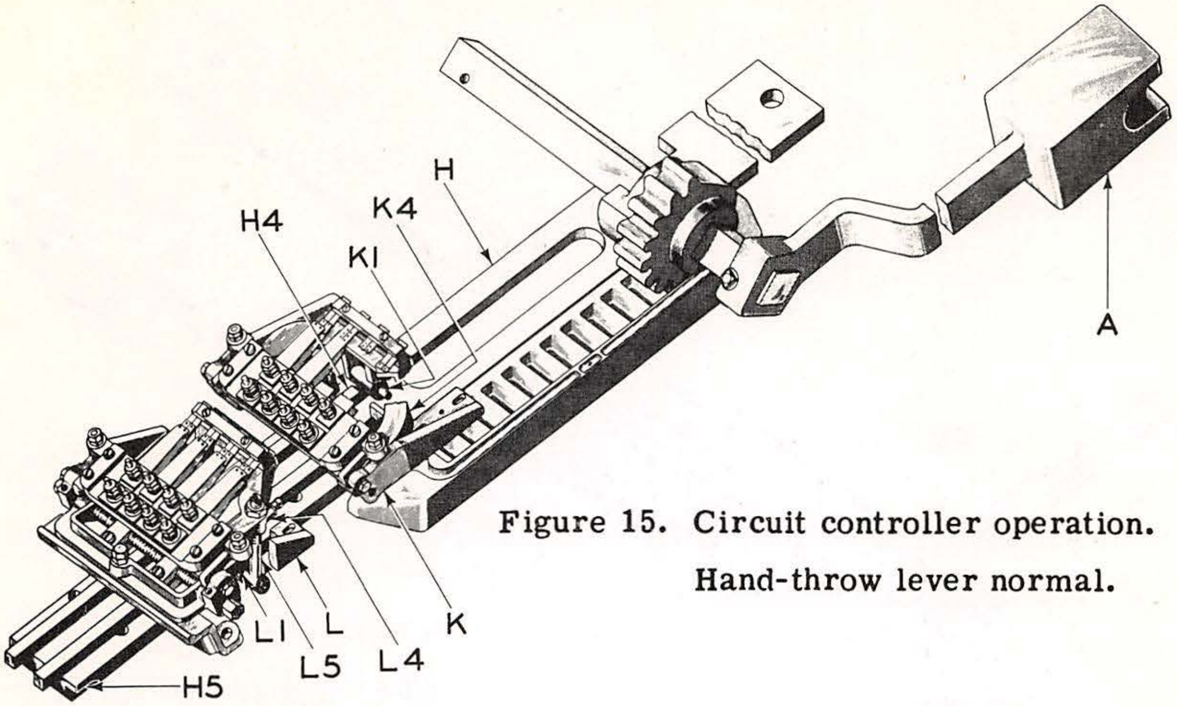


Figure 15. Circuit controller operation. Hand-throw lever normal.

3. Operation of Circuit Controllers

The normal and reverse circuit controllers may be actuated either (1) by movement of the locking plunger, or (2) by movement of the detector bar. In regular operation of double-locking machines, action (1) is primarily responsible for controller operation, and the following discussion will be confined to this type. Action (2) checks action (1) and will be covered in the discussion of point detection.

Each circuit controller carries four pairs of contacts, one of each pair fixed, the other movable on a rocker. Any pair may be arranged open or closed in the up position of the rocker (or in the down position, as the case may be) as circuit conditions require.

With the switch in the normal position (Figure 15) locking plunger (H) is in its extreme position away from the heel of the switch. In this position, roller (K1) on normal controller (K) is

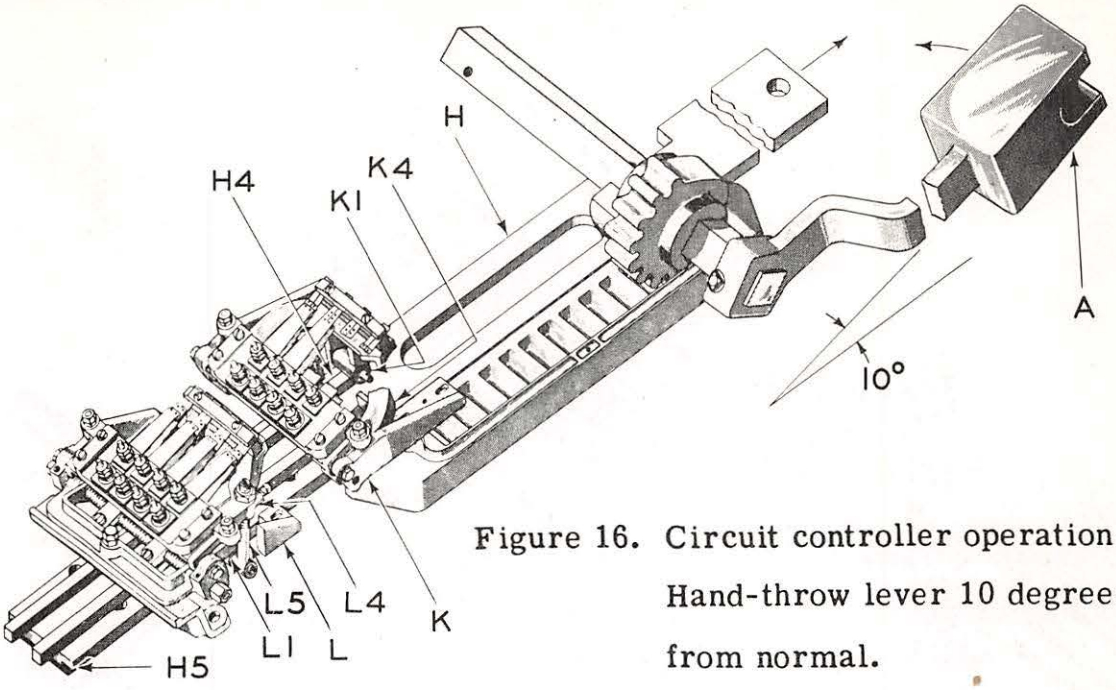


Figure 16. Circuit controller operation. Hand-throw lever 10 degrees from normal.

held down by springs (not shown) acting on rocker (K4). Under these conditions, normal controller (K) is in its "clear" position, with circuits arranged to establish a clear indication for the main track.

At the same time, roller (L1) on reverse controller (L) is held on the lower surface of locking plunger (H) by springs (not shown) acting through rocker (L4) and arm (L5). Under these conditions, reverse controller (L) is in its "restrictive" position, with circuits arranged to establish a restrictive indication for the turnout track.

When locking plunger (H) moves toward the heel of the switch (Figure 16) with movement of hand-throw lever (A) toward the reverse position, roller (K1) rides up the slant surface of cam (H4). Rocker (K4) is forced up, changing contacts so that circuits are arranged to set up a restrictive indication for the main track. This occurs when hand-throw lever (A) has moved 10 degrees from normal. Controller (K)

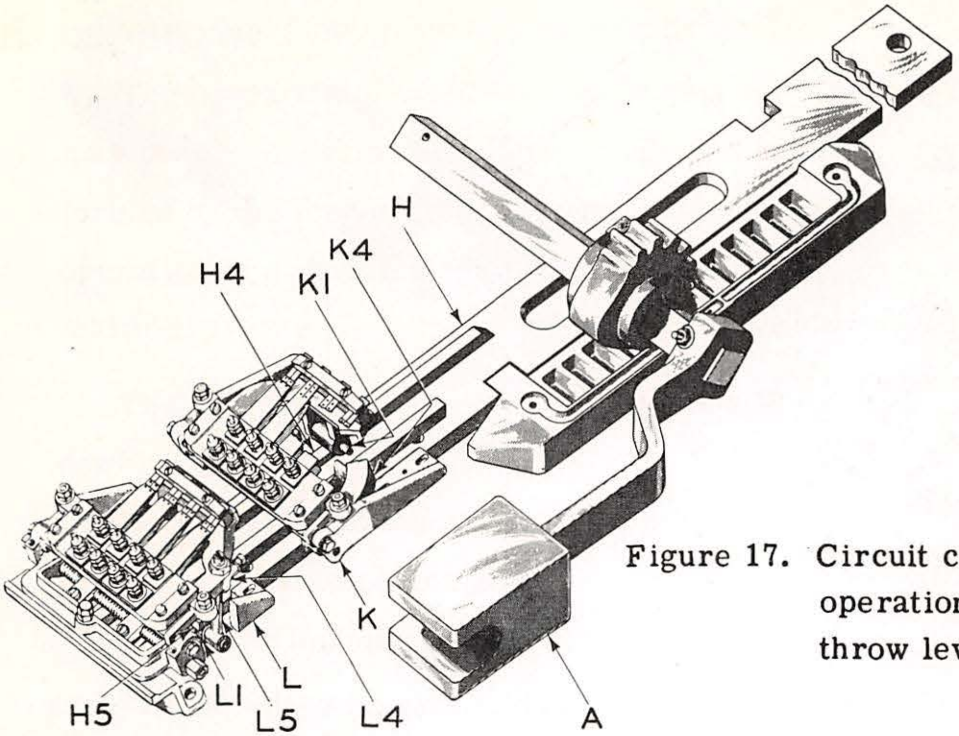


Figure 17. Circuit controller operation. Hand-throw lever reverse.

remains in this position for the balance of the stroke. Referring to "Locking of Switch", page 12, it will be noted that the switch is not unlocked until hand-throw lever (A) has moved 23 degrees. Thus the mechanism sets up a restrictive indication for the main track well before the switch points are unlocked. When hand-throw lever (A) has moved 170 degrees toward reverse, roller (L1) on reverse controller (L) begins to move up into notch (H5) on the lower surface of locking plunger (H). This action is complete when hand-throw lever (A) reaches the full reverse position, Figure 17. Reverse controller (L) is then up in its "clear" position, and circuits are arranged to set up a clear indication for the turnout track. It should be noted that the turnout track is not given a clear indication until reverse locking has been established.

Restoring the hand-throw lever to normal reverses the above actions.

When reverse controller action is desired without reverse locking, it is necessary to use reverse point detection for controller operation. This is done to avoid the possibility of erroneous controller actuation which might occur if operation were by locking plunger only, since it would be possible to have conditions in which the plunger might move into reverse position without corresponding switch point movement. On reverse locking machines, as previously pointed out, this possibility does not arise, since the locking plunger cannot move into full reverse position unless the lock rod assembly (hence, the switch points) has moved to the reverse position.

4. Operation of Point Detectors

(a) Normal Point Detector

The function of the normal point detector is to actuate the normal controller to its "restrictive" position when the switch points have moved 1/4 inch from the closed normal position. In regular operation, the normal controller will be actuated by the locking plunger before any movement of switch points occurs; hence, the point detector action usually serves only to check plunger actuation, and this type of operation will be described first.

With the switch locked in the normal position, Figure 18, detector bar (M), which is connected to the switch points, is in its position of maximum travel to the right. In this position, roller (N1) on latch bar actuator (N) is held in notch (M1) by the action of spring (P) through latch bar (R).

As the switch is reversed, detector bar (M) moves to the left. Roller (N1) rides out of notch (M1), forcing latch bar actuator (N) toward the heel of the switch. This motion is transmitted to latch bar (R), which is driven against spring (P), moving cam (R1) under roller (K1) of normal controller (K). Normally, roller (K1) will have been raised by the cam on the locking plunger before this occurs (see "Operation of Circuit Controllers", page 19), and latch bar (R) serves only to check the actuation. If, however, roller (K1) has not been raised by plunger action, cam surface (R1) will do so, and establish a restrictive indication for the main track.

An additional feature of the normal point detector mechanism is a latch to hold the normal controller in the "restrictive" position after any forced movement of the switch points away from normal (such as might occur in an improper trailing movement), even though the points subsequently return to normal. In such cases, when the points are sprung from normal, locking plunger (H) remains fixed, but detector bar (M) is forced to the left. As described above, roller (N1) comes up out of notch (M1), latch bar actuator (N) moves toward the heel of the switch, latch bar (R) moves similarly, and cam surface (R1) forces roller (K1) up. Normal controller (K) is thus placed in the "restrictive" position.

At the same time, latch (R2), which is attached to latch bar (R) so as to pivot about a horizontal axis, moves off latch retainer surface (S1) on frame (S). When the lip of latch (R2) moves past the edge of latch retainer surface

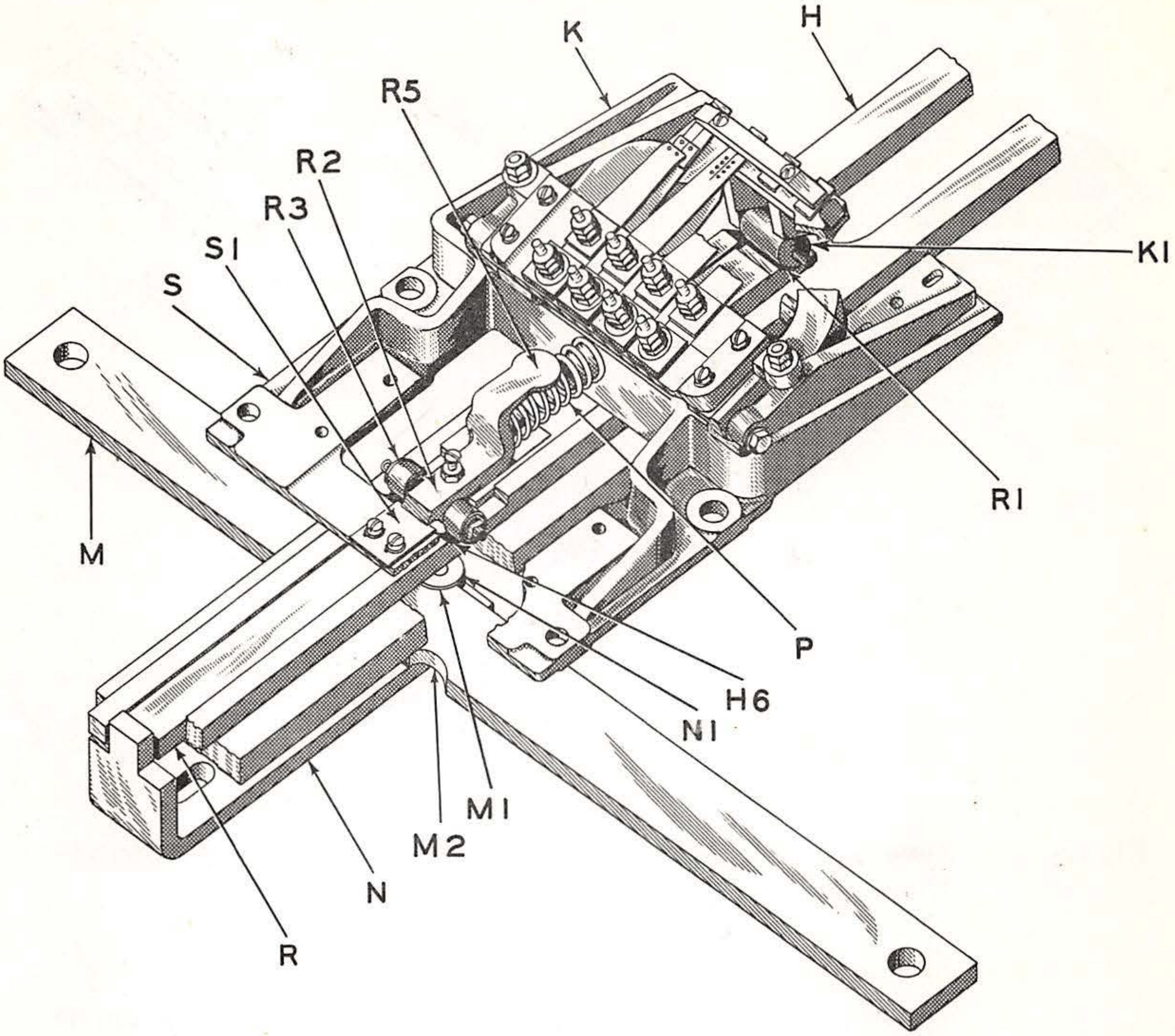


Figure 18. Normal point detector operation. Switch normal, hand-throw lever normal.

(S1), it pivots downward under pressure of spring (P). Now, even if the switch points return to the normal position, latch bar (R) can no longer return to its normal position because of the interference between frame (S) and latch (R2). As a result, cam surface (R1) is held under roller (K1), and normal controller (K) is retained in the "restrictive" position.

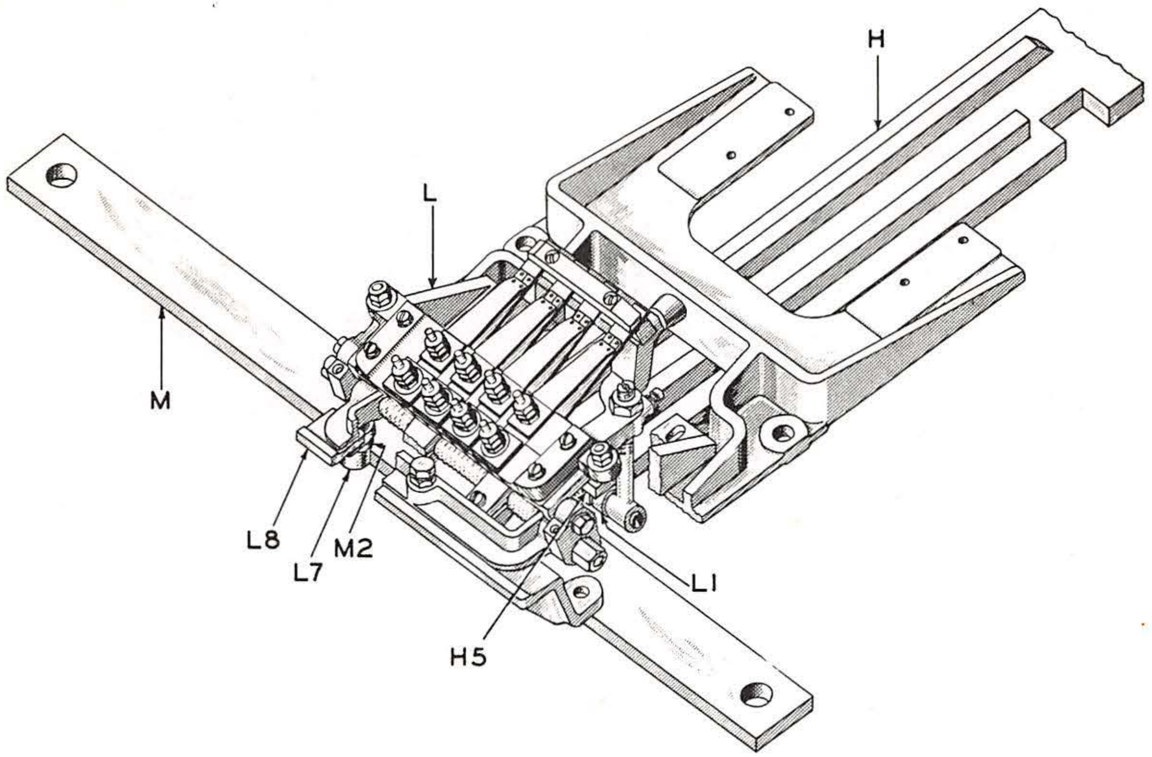


Figure 19. Reverse point detector operation. Switch reverse, hand-throw lever reverse.

To prevent tripping latch (R2) in regular operation of the switch machine to reverse position, locking plunger (H) is equipped with two cams (H6) which move under a pair of rollers (R3) on latch (R2) whenever locking plunger (H) moves toward the heel of the switch, as occurs in regular switch reversal. These rollers hold latch (R2) in the raised position when latch bar (R) moves toward the heel of the switch during switch reversal, and thereby prevent latch (R2) from tripping down. When the switch is restored to normal, cams (H6) continue to support latch (R2) until near the end of the return stroke of locking plunger (H), by which time latch bar (R) has returned to its normal position, and latch (R2) therefore comes down on latch retainer surface (S1) when cams (H6) move from under rollers (R3) at the end of the stroke.

A tripped latch may be reset by pressing on arm (R5) of latch (R2), raising the lip of latch (R2) above the edge of latch retainer surface (S1), thereby permitting latch (R2) ~~bar (R)~~ to move over the edge of retainer surface (S1) under pressure of spring (P). The latch may also be reset by throwing the hand-throw lever to reverse and back to normal, since this drives latch bar (R) toward the heel of the switch, raises latch (R2) by means of cams (H6) and rollers (R~~4~~3), and then permits the mechanism to return to normal position as in regular operation.

(b) Reverse Point Detection

The function of the reverse point detector is to actuate the reverse controller to the "restrictive" position when the switch points have moved 1/4 inch from the full reverse position. In regular operation of a normal and reverse locking machine, the reverse controller will be actuated by the locking plunger (as described under "Operation of Circuit Controllers", page 18), before the switch points have moved; hence the point detector action, in the usual case, is one of checking the proper operation of the plunger. This is the case considered first.

With the switch in reverse position, Figure 19, detector bar (M) is in its extreme left-hand position. In this position notch (M2) on detector bar (M) is aligned with roller (L7) on actuating arm (L8) of reverse controller (L). Thus, in regular operation, when locking plunger (H) moves to its extreme position toward the heel of the switch during switch reversal, and roller (L1) moves into notch (H5), roller (L7) drops into notch (M2) and the reverse circuit controller moves into the "clear" position. If for any reason the switch points have not moved into the full reverse position, detector bar (M) will not have moved enough to position notch (M2) in line with roller (L7). Roller (L7) will then bear against the edge of detector bar (M), and reverse circuit controller (L) will be prevented from moving into the "clear" position.

Likewise, if after a regular reversal of the switch, the switch points are forced more than 1/4 inch from the full reverse position, the corresponding motion of detector bar (M) will force roller (L7) out of notch (M2), and reverse circuit controller (L) will be actuated to the "restrictive" position.

It should be noted that on single locking machines, on which only normal locking is provided, notch (H5) on locking plunger (H) is omitted, and reverse circuit controller actuation is exclusively through detector bar action. See "Operation of Circuit Controllers" for details, page 21.

III; ADJUSTMENTS

The following adjustments are provided on the Model 9 switch machine (or on associated equipment) to facilitate installation and to insure proper operation:

1. Throw Rod

Fixed throw of 6 inches at the throw crank is adjusted to the required throw at basket on the No. 1 rod.

2. Lock Rod

   Normal locking setting is made by adjusting the lugs at either the front rod or the machine, or both. Reverse locking is then adjusted by shifting the position of the reverse locking notch on the lock rod assembly.

3. Detector Rod

   Normal detection adjustment is made by coarse setting of jaw fitting, then fine setting by eccentric ball. Reverse detection adjustment is next made by the screw on the reverse controller, which shifts the position of the reverse controller actuating roller.

4. Target Staff

   "Wash board" coupling permits alignment of target and lantern with the track in 5-degree steps.

5. Normal Controller

   Screw adjustment provided to set rocker position for proper contact action. Additional screw adjustment is supplied on latch bar actuator to set proper normal position of latch bar.

6. Reverse Controller

   Screw adjustment provided for setting proper position of point detection roller. Additional adjustment is supplied to set the correct contact position. When reverse locking is used, with plunger controller actuation, an additional adjustment is furnished to adjust to the previously established point detector actuation.

IV. LUBRICATION

The horizontal and vertical shafts in the Model 9 machine are lubricated with grease through standard pressure fittings. When a pedestal for a high target is supplied, an additional pressure fitting is included thereon.

Rollers on the rack are oiled from above at a single operation by means of oil channels and drilled passages which carry the lubricant from the point of application to the end guide rollers and the center escapement roller. Rack guides are oiled directly, on one end through the machine cover opening and on the other end of machine through a hole specially provided in the case.

The plunger and latch bars are lubricated by direct oil application. Overflow of the oil from the plunger lubricates the guides. Lock and detector rods are also directly oiled.

Oil holes are provided on the rocker bearings of controllers for light oil lubrication. Controller rollers are oiled directly.

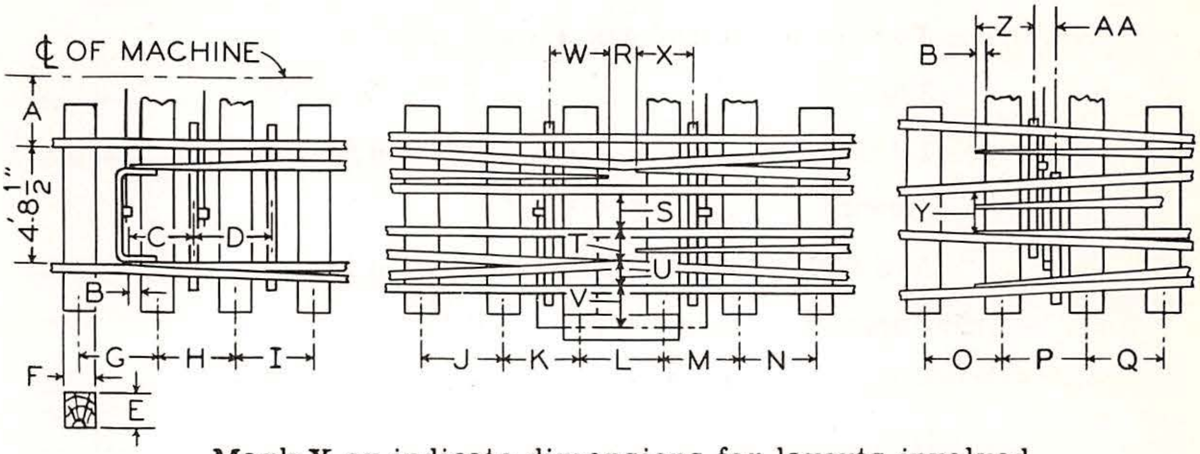
V. ORDERING INFORMATION

At the time of writing, reference numbers have not been assigned to cover all combinations of features available in the Model 9 hand-operated switch machine. The key drawing number is 49600; additional suffix and group numbers will be added as needed to cover individual variations.

The appended questionnaire is designed to secure all pertinent information required to supply a machine meeting a customer's requirements. Where possible, however, it is helpful to have, in addition, a detailed drawing of the proposed layout.

VI. ENGINEERING DATA REQUIRED FOR SWITCH LAYOUTS

Based on questionnaire SK-5737, dated October 27, 1939, and revised.



Mark X or indicate dimensions for layouts involved.

1. Layouts

(a). Single Switch __________ Derail (Type) ________________

Double slip switch ______ Movable point frog switch ______

Special ________________

(b). Machine Location. A ___ Left-hand ____ Right-hand ______

(c). Turnout. Number ______ Left-hand ______________________

Right-hand ______________

(d). Ties. Height E ________ Width F _______________________

Spacing (Tie centers) G _______ H _______ I _________

J _______ K _______ L _________

M _______ N _______ O _________

P _______ Q _______

Can ties be moved if desired? ______________

(e). Points nearest machine. Closed ________ Open __________

(f). Frog angle. On MPF layout ________ On DSS layout _______

(g). Distance between points on MPF. R ____________________

(h). Distance between rails on MPF. S ______ T ______ U _____ (j). Distance between rails at points on DSS. Y__________

(k). Location of No. 1 rod and No. 2 rod. C________D________

X________W________Z________AA________

(l). Type of No. 1 and No. 2 rod.

3/4" x 2"______________ 3/4" x 2-1/2"______________

1" x 2"______________ 1" x 2-1/2"______________

Special__________

Are rods insulated?________By whom?______________

(m). Location of crank stand (MPF).

Same side as mach. ________Opp. side of mach. ________

Distance ℄ of mach. to ℄ of crank ________V________

2. Switch Machine

(a). Type of machine. ______________________________

(b). Position of machine. Top of tie __________

Top of tie plate ______________

(c). Are ties framed? ____________ How much? __________

(d). Fastening down machine. Thru-bolts __________

Tapped into tie plate ______________

(e). Type of coupling for wire entrance. Size ____________

For Greenfield conduit ________For parkway cable______

For rubber hose ____________

(f). Throw-rod connections at machine.

Plain pin and cotter______Pin with oiler and cotter______

Bolt, nut & cotter____Bolt with oiler, nut and cotter____

(g). Lock-rod connections at machine.

Bolted to lug on lock rod assem. __________

Special ____________

(h). Detector-rod connections at machine.

Bolted to lug on detector rod assem. ____________________

Special _______________

(j). Locking requirements. Normal only ____________________

Normal and reverse __________________

(k). Point detection. None __________ Normal only ____________

Normal and reverse ___________________

(l). Circuit controllers. None _________ Normal only __________

Normal and reverse ___________________

(m). Circuit controller contact arrangements.

Normal Controller Only, Switch Normal

(i) SPACE NUMBER
1 2 3 4
▲ ▲ ▲ ▲
4 Contacts Made
____

(ii) SPACE NUMBER
1 2 3 4
▽ ▽ ▽ ▽
4 Contacts Open
____

(iii) SPACE NUMBER
1 2 3 4
▽ ▲ ▲ ▽
2 Contacts Made
2 Contacts Open
____

(iv) SPACE NUMBER
1 2 3 4
— — — —
____
SPECIAL
Indicate desired arrangement.

Normal and Reverse Controllers, Switch Normal

(i) SPACE NUMBER
1 2 3 4
▲ ▲ ▲ ▲
Normal
4 Contacts Made
▲ ▲ ▲ ▲
Reverse
4 Contacts Made
____

(ii) SPACE NUMBER
1 2 3 4
▽ ▽ ▽ ▽
Normal
4 Contacts Open
▽ ▽ ▽ ▽
Reverse
4 Contacts Open
____

(iii) SPACE NUMBER
1 2 3 4
▽ ▲ ▲ ▽
Normal
2 Contacts Made
2 Contacts Open
▽ ▲ ▲ ▽
Reverse
2 Contacts Made
2 Contacts Open
____

(iv) SPACE NUMBER
1 2 3 4
— — — —
Normal
— — — —
Reverse
____
SPECIAL
Indicate desired arrangement.

(n). Target staff.

Height______ Type of tip________

Is drilling desired in staff for target? Yes____ No____

(If yes, include sketch of drilling required).

Is target required? Yes____ No____

(If yes, include sketch of target or other positive identification).

(p). Electric switch lock requirements. None____________

Model 9. Normal only______ Normal and reverse______

Model 10. Normal only______ Normal and reverse______

3. Rails and Switch Points

(a). Type and size of rail. ________________________

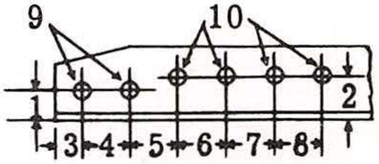
(b). Switch point reenforcement.

None ________________

Single reenforcement_____ Double reenforcement ______

Thickness of reenforcement ____________

(c). Edge of tie to point. B_____Can this be changed?______



(d). Movement of points. ________

(e). Drilling of points. ________

1____ 2____ 3____ 4____ 5____ 6____ 7____ 8____

Size of hole 9_____ 10_____

4. Rail Braces and Riser Plates

(a). Type of rail brace. ____________

(b). Method of fastening brace. Tapped into tie plate_______

Thru-bolts ___________

(c). Size of riser plate. ____________

(d). Are riser plates cut to fit turnout?______________

(e). Size of rivets desired.____ Number of holes in riser____

5. Tie Plates

(a). Size of plates desired. __________

(b). Are tie plates insulated? ________ Butt insulation ________

Lapped insulation ________ Open (no insulation) ________

(c). Is machine to be insulated from tie plates? __________

(d). Are tie plates to be milled to fit rails? ______________

6. Rods

(a). Type of front rod desired. ______________

Size of lugs ________ Size of connecting rod __________

(b). Type of lock-rod connections.

Flat ________ Round ________ Size ________ Threaded ______

Short rod bolted to lug on machine __________

Continuous thru machine ________________

(c). Type of detector-rod connections from front rod.

Flat ________ Round ________ Size __________

(d). Throw rods on MPF and DSS layout connections.

Turnbuckle ________ Screw Jaw __________

Special __________

7. Miscellaneous

(a). What material will railroad furnish? ____________

* * *

Circuit Engineering Course at RIT

Under a joint training program by the Rochester Institute of Technology and our organization, some 33 men, mostly from the armed services, are being and will be trained as railway signaling circuit engineers.

A class of eighteen men, whose training started in December, were graduated from RIT in the last week of February; and, in the first week of March fifteen new men will start on the 10 weeks' intensive course. After graduation all men report to the main office for placement.

The course consists of lectures and lab work, using apparatus supplied from our exhibit room and factory. The emphasis is placed on circuit structure and analysis, and actual hook-ups are made of typical circuits commonly used in signaling. A mass of reading material, company bulletins, handbooks, magazine reprints, development sheets, and books on train operation and railway signaling supplement the material covered in class discussions.

This course should serve to fill a real need for circuit men, both in the main office and in our district offices. Candidates are selected on the basis of their previous experience in railroad work and their acquaintance with the fundamentals of electricity.

* * *

Biographies of the Month

This issue features the biographies of Messrs. Hudson, Taylor, Washburn, and Werthmuller, who celebrate their birthdays this month.

Hal A. Hudson, signal and electrical superintendent, Central Lines, Southern Railway, with headquarters in Cincinnati, Ohio, was born in Atlanta, Ga., March 29, 1898. He received his education in Atlanta, where he attended the technical high school and the Georgia School of Technology.

Mr. Hudson first entered railroad service on May 28, 1917, as an assistant storekeeper with the Southern at Greenville, S. C. Since

November 4 of the same year, when he became assistant signal maintainer, Mr. Hudson has served the signal and electrical department of the Southern continuously. He occupied positions successively as follows: signal maintainer, February 28, 1918; signal foreman, November 28, 1918; general signal foreman, August 1, 1925; assistant signal supervisor, May 1, 1926; signal supervisor, August 1, 1926; supervisor of construction, February 1, 1927, returning to the position of signal supervisor later in the same year. He was promoted to assistant engineer, with headquarters in Washington, D. C. in March, 1936, and in August, 1941, he was made signal and electrical superintendent, his present position.

Roy E. Taylor, signal engineer, New York, New Haven and Hartford, with headquarters in New Haven, Conn., was born in Shapleigh, Maine, on March 7, 1884. He entered the service of the New Haven as a draftsman on December 1, 1906. He was appointed inspector on December 17, 1910, becoming assistant engineer on September 6, 1912, and chief draftsman on July 16, 1915. On July 1, 1925 Mr. Taylor was made office engineer and again became chief draftsman on May 1, 1933. On September 21, 1934 he was made draftsman and on April 1, 1936, general draftsman, returning to the position of office engineer on May 1, 1940. On April 16, 1941 he became office and construction engineer, and on July 1, 1942, he was appointed signal engineer.

George A. Washburn, assistant superintendent signals, Chesapeake and Ohio, with headquarters in Richmond, Va., was born in Topeka, Kan., on March 1, 1889. He graduated from Washburn College, Topeka, in 1912, with a B.A. degree and from Kansas University in 1914, with a B.S. in electrical engineering. He was engineer in the power house of the Municipal Electric Light and Water Department of Ponca City, Okla., from July, 1914, to September, 1915.

Mr. Washburn was an apprentice signal engineer with the Union Switch and Signal Company from November, 1915, to June, 1917. From September, 1917, to May, 1918, he was signal draftsman in the office of signal engineer, Eastern Lines, of the Santa Fe at Topeka. From May, 1918, to July, 1919, he was with the 314th Field Signal Battalion, 89th Division, U.S.A. When he received his discharge from the service, he returned to the office of signal engineer, Eastern Lines, Santa Fe at Topeka, as a signal draftsman, later becoming chief draftsman, which position he held until September, 1922, when he was transferred to the signal engineer system office as signal draftsman in connection with the installation of automatic train control on the Illinois division of the road. In May, 1925, he was promoted to chief draftsman in the signal engineer system office. In April, 1926, he was appointed general signal inspector on the Chesapeake and Ohio with headquarters in Richmond, Va. In May, 1940 he was promoted to the position of assistant superintendent signals on the same road.

Louis S. Werthmuller, signal engineer, Missouri Pacific, with headquarters in St. Louis, Mo., was born in St. Louis on March 15, 1888. He was engaged in electric construction work for the street railway company in that city and as an operator in a power house, before entering railway service in 1912, as a signal maintainer on the St. Louis terminal division of the Missouri Pacific. On May 1, 1913, he was promoted to signal foreman and on December 1, 1916, to signal supervisor of the same division. On August 10, 1922, Mr. Werthmuller was appointed train control examiner, and on November 1, 1926, he was promoted to assistant signal engineer, with headquarters in St. Louis, Mo. In October, 1941, he was appointed signal engineer.

Mr. Werthmuller has been an active member of the Signal Section, A.A.R., having served in recent years as a subcommittee chairman on Committee I - Economics of Railway Signaling.

* * *

AN ADDITION

FOR YOUR MARCH 1946 ISSUE OF

G-R-S NEWS - - -

- Throw away pages 33, 34, 35, and 36 of the March 1946 issue.
- Insert the attached pages 33, 34, 35, 36, and 37.

THE REASON - - -

We learned last week that Joe Muller's birthday was in the month of March, March 7 to be exact. Joe is so well known to us all that we thought you would want to read about his interesting career in the field of railway signaling.

March 25, 1946

5. Tie Plates

(a). Size of plates desired. __________

(b). Are tie plates insulated? ________ Butt insulation ________

Lapped insulation ________ Open (no insulation) ________

(c). Is machine to be insulated from tie plates? __________

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Joseph P. Muller

Joseph P. Muller, engineer of signals and telegraph, Boston and Maine, Maine Central, and the Portland Terminal Company, with headquarters in Boston, Mass., was born in San Francisco, California, March 7, 1886.

Mr. Muller's railroad career began in 1907 when he joined the Hudson and Manhattan as maintainer, later becoming foreman. In 1908 he left the H. & M. to go with the New York Central as signalman and foreman. From 1910 to 1914 he was engaged in construction work in and around New York City, with our company on the Electric Zone, and with the Union Switch and Signal Company on Pennsylvania Station.

In 1914 Mr. Muller entered the service of the Southern Railway as assistant signal supervisor advancing to signal supervisor in 1917, to signal and electrical supervisor in 1919, and to chief signal and electrical inspector in 1921.

On November 1, 1930 Mr. Muller became associated with the Boston and Maine as signal construction engineer, and was promoted to assistant signal engineer on April 15, 1931. On July 1, 1931 he was made signal engineer. On May 16, 1933, his jurisdiction as signal engineer was extended to include the Maine Central and the Portland Terminal Company. On March 1, 1936, he was made engineer of signals and telegraph.

Mr. Muller has been active for a number of years in the Signal Section of the A.A.R. He was chairman of Committee III - Automatic Train Control and Signals - from 1942 to 1945; on the Committee of Direction from 1938 to 1945; and Chairman of the Signal Section in 1944.

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G-R-S NEWS
February 1946

Type SC Color-Light Signal

A handbook on the Type SC Signal is being prepared. It will contain the following information which is included in this issue of the News as advanced information.

If you have any comments or additions, will you kindly send them in to the Advertising Department within the next week or two, so that they can be included in the final publication.

I. INTRODUCTION

The object of this handbook is to explain the general features and operation of the Type SC color-light signal, and to give instructions for its installation and maintenance.

II. GENERAL DESCRIPTION

The Type SC signal, Figure 1, is a color-light signal with one optical system through which are projected three color aspects. The signal has two principal parts:

1. The signal housing, which is bolted to the signal mast or bridge as a high signal or to a foundation as a dwarf signal.
2. The signal mechanism, which can be removed from the housing. The mechanisms are interchangeable with other mechanisms bearing the same circuit number on the name plate.

A. The Signal Housing

The signal housing, Figure 1, protects the mechanism and provides facilities for terminating the field wires. It carries a plugboard, terminal board, outer lens and deflecting roundels, and the various fittings for high or dwarf use.

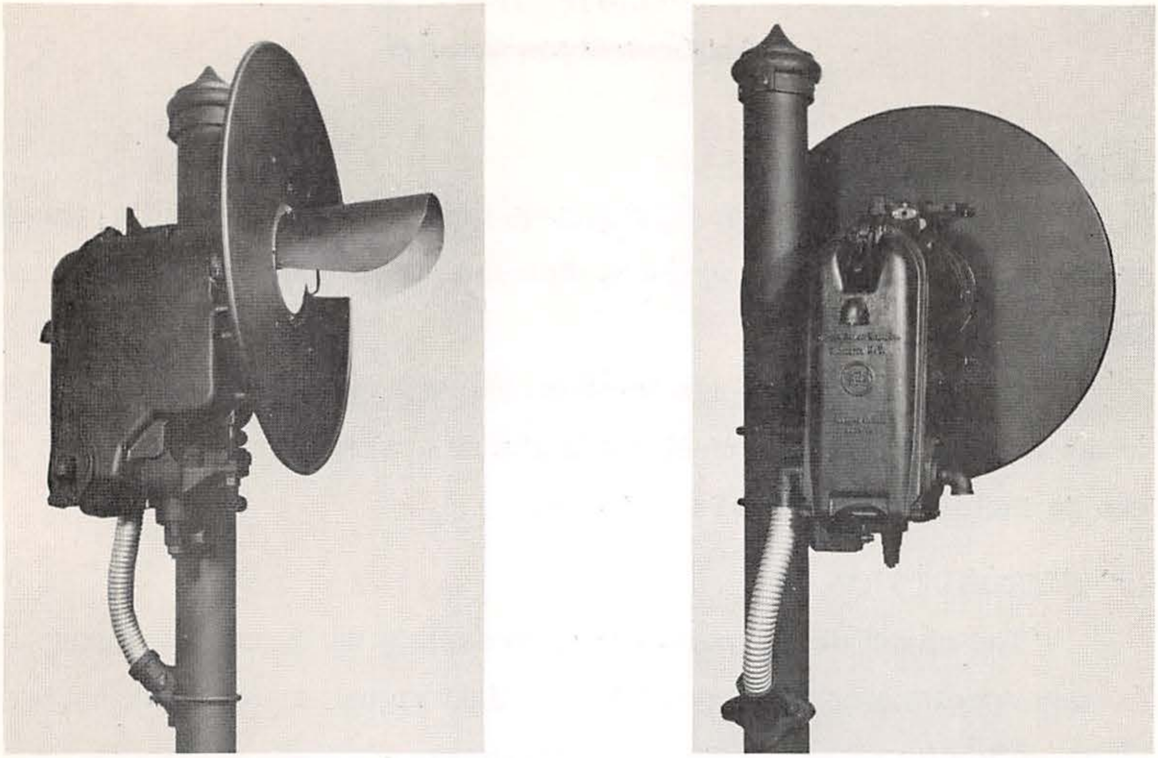


Figure 1. Side and rear views of Type SC signal mounted on side of mast with resilient mounting bracket. Rear view shows bottom-hinged housing door. See Figure 2 for side-hinged housing door.

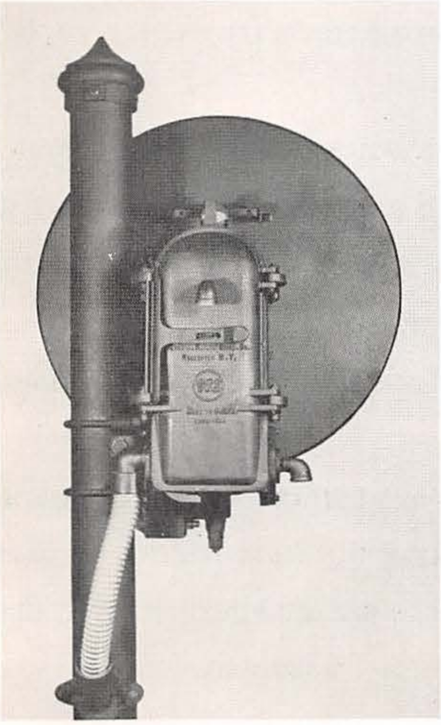


Figure 2. Type SC signal equipped with side-hinged housing door. Hinges and latch fittings may be transposed to have door left-hand or right-hand opening as desired.

As shown in Figure 1, the housing is equipped for side-of-mast mounting. Other mounting brackets are furnished for top-of-mast, bridge, or dwarf mounting. See under "Installation and Maintenance". All Type SC operable signals are resiliently mounted.

Housings are available with the door hinged at the bottom, as shown in Figure 1, or with the door hinged at the side, as shown in Figure 2. Hinge and latch fittings on the side-opening door may be transposed in the field to make the door either right-hand or left-hand opening, as desired.

When used as a dwarf signal, the signal is furnished without the black background and the sighting device (on top).

Overall dimensions of the housing alone (without the sighting device) are:

Height (including mounting stud) 29 inches

Width (measured at lens bezel ring) 10 inches

Depth (compound lens, less hood and ventilator) 21-1/2 inches

Weight (with sighting device and compound lens, but without mechanism, hood, background, and mounting bracket) 137 pounds.

The background is 35 inches in diameter; the hood is 12 inches long for high signals; 6-1/2 inches long for dwarf signals.

The door of the housing, when opened, describes an arc having a clearance radius of 23-1/2 inches (bottom-hinge type) and 11-1/2 inches (side-hinge type).

Several options are available on couplings, both for flexible conduit and parkway cable. A flexible conduit coupling is shown in Figure 1 bolted to the side of the housing. Others are shown

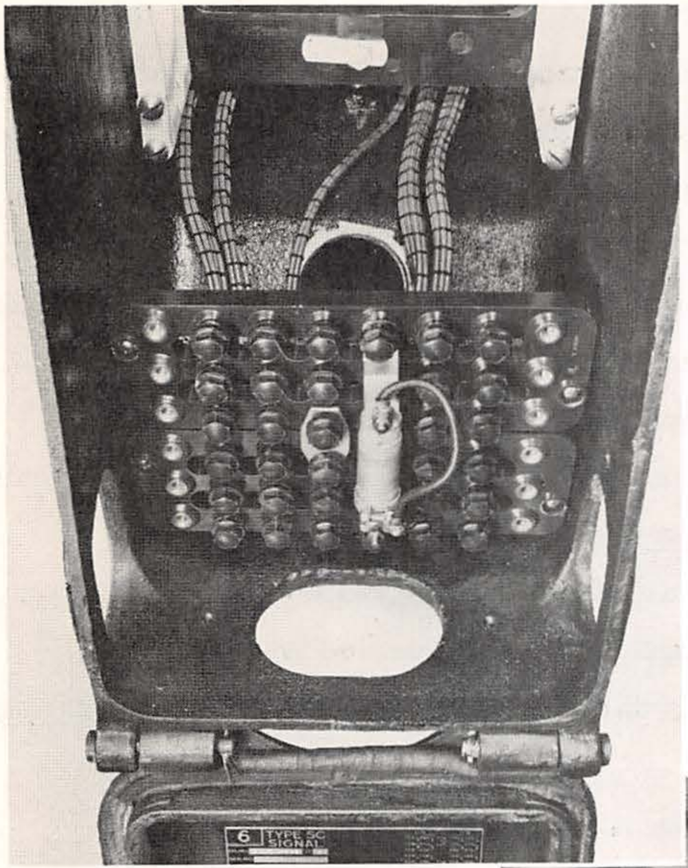


Figure 3.
Four wire inlets are available. Inlet shown just above terminal board is supplied only in top-of-mast housing.

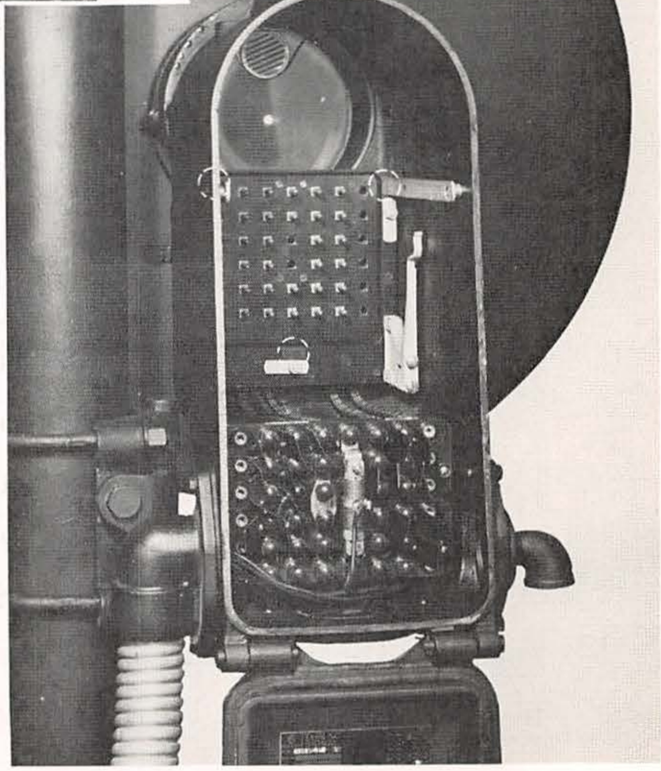


Figure 4.
Interior of housing with mechanism removed showing terminal board with adjustable lamp resistor and lightning arrester, track on which mechanism slides, leaf springs which lock mechanism in place, and plugboard. Circles on plugboard locate raised pads against which the mechanism plugboard bears.

in Figure 32, and are discussed more fully under "Installation and Maintenance," page 39. The couplings are threaded to take 2-inch flexible conduit. The mast couplings for 2-inch conduit or parkway, are furnished for either clamping to or screwing into the mast.

Four wire inlets, Figure 3, are available - on the bottom, sides, and the 45-degree slope near the bottom of the housing. The last is furnished only on top-of-mast housings.

The rear view of the housing with the door open, Figure 4 shows (from top to bottom), the 40-degree deflecting close-up roundel, the outer lens, the plugboard, the tracks on which the mechanism slides, the terminal board, the wire inlets, and lower ventilator. The sighting device with the crossed hairlines is bolted to the top of the case.

In the compound-lens signal a small 40-degree deflecting roundel is provided inside the housing to deflect a portion of the main beam of light downward (or upward for dwarf signals) at 40 degrees sc that enginemen may see the signal aspect if stopped at the signal. The roundel is adjustable through a hand hole provided in the lens barrel.

The plugboard is bolted to the housing and consists essentially of one piece of molded plastic with contact plugs protruding at right angles from the surface against which the mechanism seats. On this surface there are three molded pads (encircled in Figure 4) which butt against the mechanism plugboard to insure accurate positioning in the housing. See Figure 9.

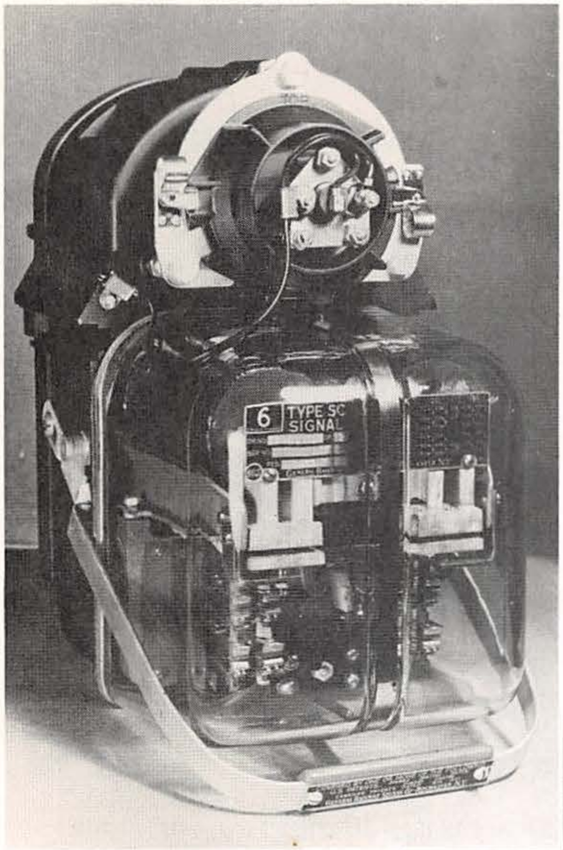


Figure 5.
Mechanism, contact end.

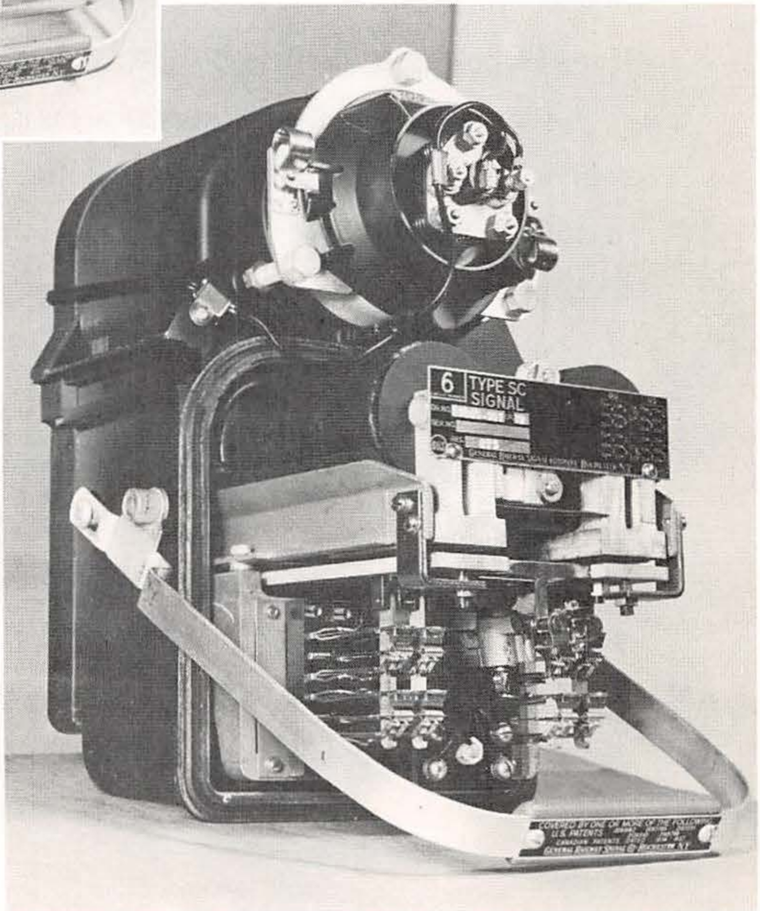


Figure 6.
Mechanism with glass cover removed, contact end.

Supported in slots near the top of the plugboard at one end and attached to the sides of the housing at the other are the two tracks on which the mechanism slides. Below these tracks are the long leaf springs which hold the mechanism tight against the plugboard when the carrying handle is in the "locked" position.

The plugboard is positioned with a master mechanism and locked in the housing before leaving the factory. This insures that mechanisms shall be interchangeable, yet give equal optical performance.

The plugboard in the housing is permanently wired to the terminal board. As shown in Figure 4, space is provided for two terminal boards so that ample terminal space is available. Some mechanisms require only one terminal board, as they are furnished with fewer contacts.

On the terminal board are a replaceable carborundum shunt gap arrester (across the windings of the mechanism) and an adjustable lamp resistor. All terminals have insulated heads for protection against short circuits. They fit standard 1/2 inch wrenches.

Fittings for various mast mountings are described under "Installation and Maintenance".

Horizontal and vertical adjustments are provided for all signals so that the beam can be directed as required.

B. The Mechanism

The mechanism, Figure 5, consists of two relays with horizontal tractive armatures which operate contacts below them. The contacts and the relay windings are permanently wired to a plugboard on the front of the mechanism.

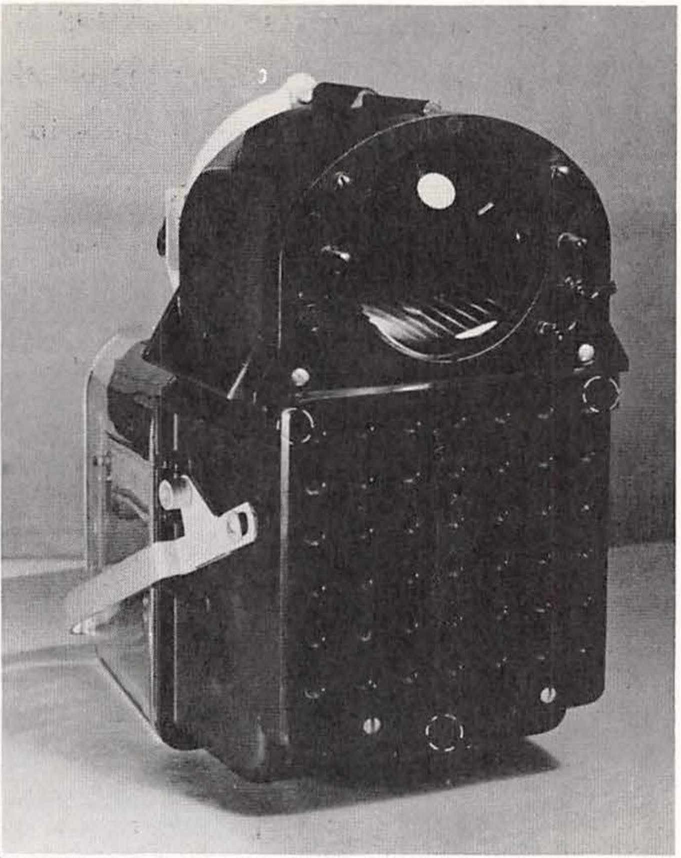


Figure 7.
Mechanism, plugboard end. Circles locate pads against which pads on housing plugboard bear.

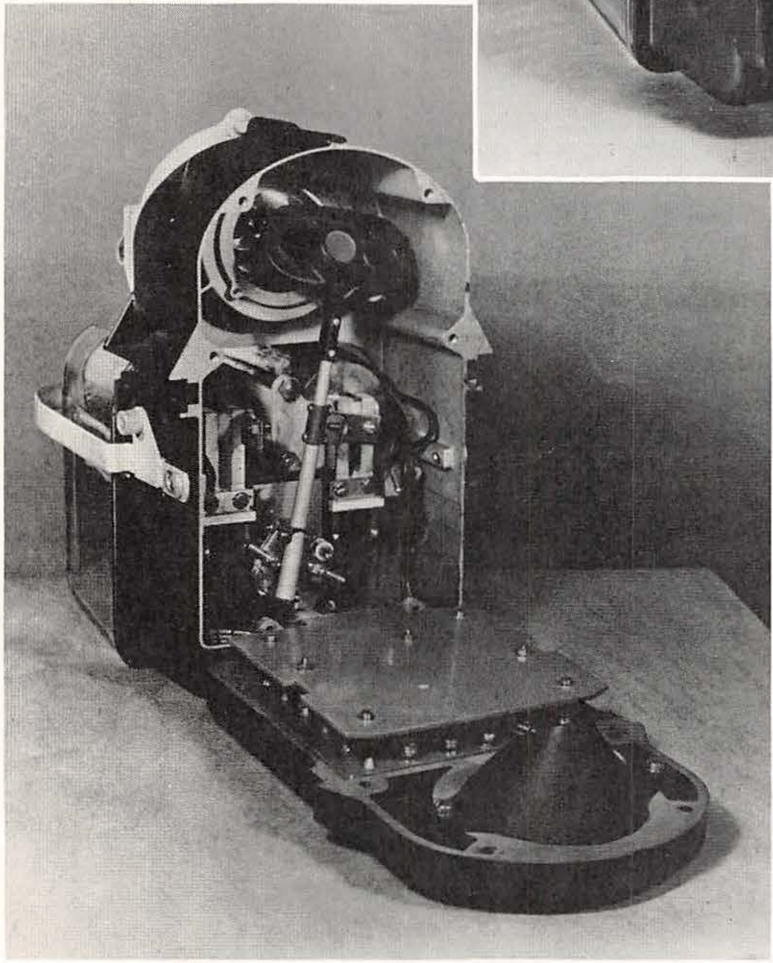


Figure 8.
Mechanism with plugboard removed to show interior.

A beam carrying the three colored discs is actuated by the movement of the armatures, thus controlling the aspect of the signal. See Figure 14.

All the working parts are totally enclosed against dust and mechanical injury; contacts, air gaps, etc. are visible through the glass case.

The mechanism also carries parts of the optical system, such as the reflector and an inner lens or plain cover glass. Figure 5 shows the reflector unit, the two relays enclosed in the gasketed glass case, and the carrying handle, which is also used for locking the mechanism in the housing. Figure 6 shows the mechanism with glass cover removed to give a clearer view of the contact structure.

The overall dimensions of the mechanism are:

Height	14-3/4 inches
Width	8-1/2 inches
Depth (exclusive of the handle)	12-1/4 inches

The polar-neutral mechanism weighs approximately 45 pounds.

The neutral-neutral mechanism weighs approximately 42 pounds.

Figure 7 shows the "inner" lens of the compound-lens signal. When a stepped-lens signal is specified, this inner lens is omitted and a plain cover glass substituted.

The plugboard and lens frame are made of one piece of molded plastic. This plugboard is the receptacle portion of the complete coupler. The plug portion is part of the housing described on page 5.

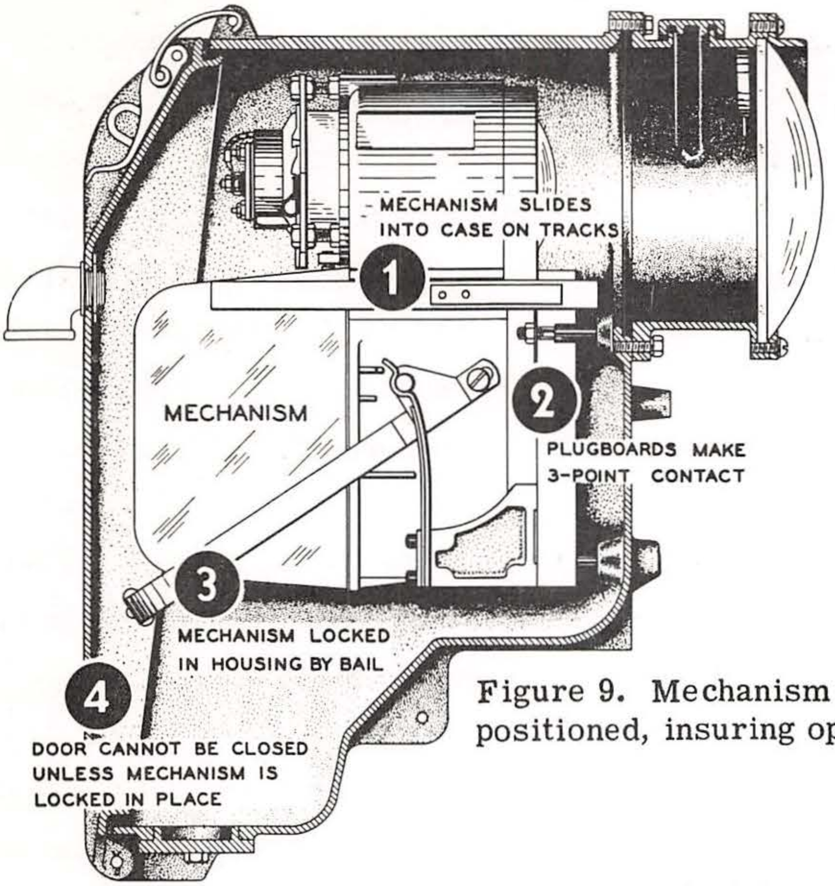

MECHANISM SLIDES INTO CASE ON TRACKS
1
MECHANISM
2
PLUGBOARDS MAKE 3-POINT CONTACT
3
MECHANISM LOCKED IN HOUSING BY BAIL
4
DOOR CANNOT BE CLOSED UNLESS MECHANISM IS LOCKED IN PLACE

Figure 9. Mechanism is accurately positioned, insuring optical precision.

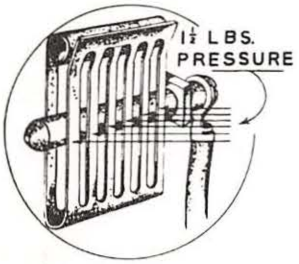

1½ LBS. PRESSURE

Figure 10a. Contact spring with plug.

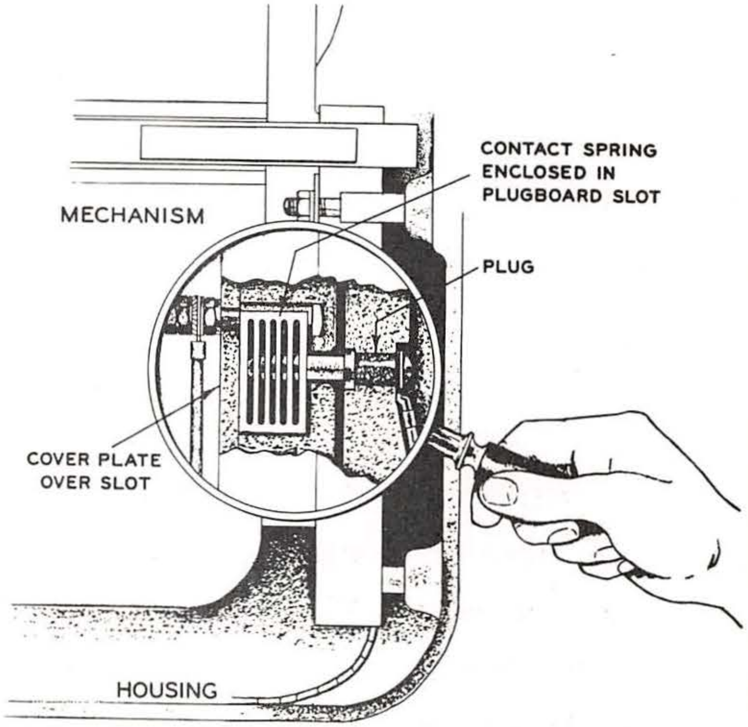

CONTACT SPRING ENCLOSED IN PLUGBOARD SLOT
MECHANISM
PLUG
COVER PLATE OVER SLOT
HOUSING

Figure 10. There is twelve-point contact between plug and spring.

Three molded pads or raised surfaces on the plug portion of the coupler, Figure 4, touch at three points (shown encircled in Figure 7) on the receptacle portion to insure accurate positioning of the mechanism in its case.

The plugboard presents a smooth surface. It is screwed to the metal frame to protect the interior of the mechanism, and is sealed to prevent unauthorized opening. By removing the plugboard, the front of the relays and the spectacle are exposed, Figure 8.

The spectacle, where it carries the color discs, is slanted away from the lens. The reason for this is to prevent beam dilution by extraneous light. This feature is described on page 13.

From this view, Figure 8, can be seen the bearings of the relay armatures. These bearings are long, needle-shaped roller bearings under several pounds pressure. They have been adopted after successful operation in such constantly moving parts as armatures of code-responsive relays used in coded track circuits.

Wires showing are from the relay windings and contacts. They are permanently connected to the back of the plugboard, which encloses the contact springs shown in Figure 10.

C. The Plug-In Feature

The plug-coupling feature is standard on all Type SC mechanisms. With this feature faster, simpler change-outs are possible. Inserting the mechanism is described on page 41.

To insure positive, low-resistance contacts in the coupler and to make it easy to pull the plugboards apart, a new type of plug contact was devised. See Figure 10.

A typical receptacle in the mechanism plugboard consists of a beryllium-copper spring, shaped as in Figure 10a, bolted to a cover plate. The spring lies in a narrow slot in the plugboard.

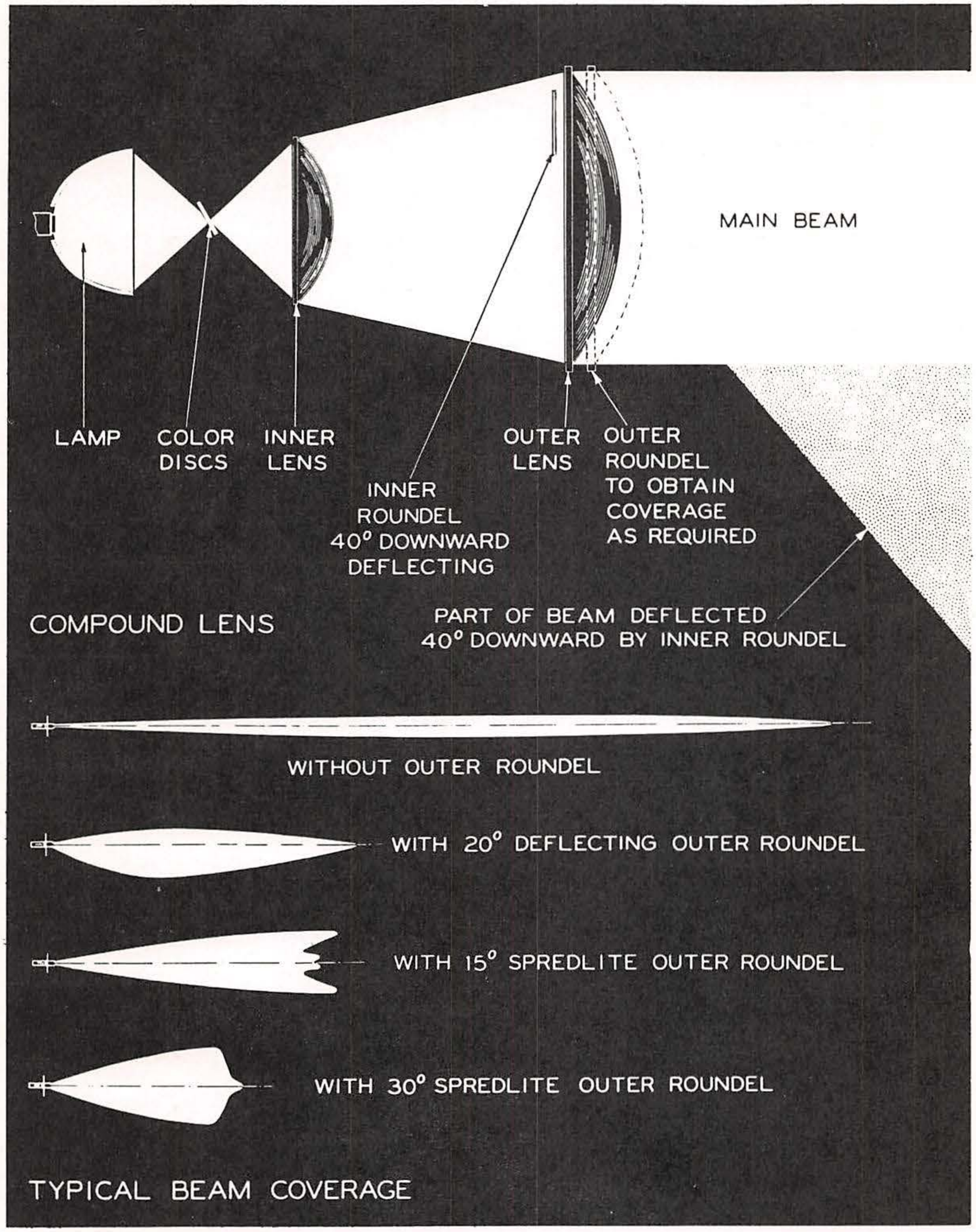

MAIN BEAM
LAMP
COLOR DISCS
INNER LENS
INNER ROUNDEL 40° DOWNWARD DEFLECTING
OUTER LENS
OUTER ROUNDEL TO OBTAIN COVERAGE AS REQUIRED
COMPOUND LENS
PART OF BEAM DEFLECTED 40° DOWNWARD BY INNER ROUNDEL
WITHOUT OUTER ROUNDEL
WITH 20° DEFLECTING OUTER ROUNDEL
WITH 15° SPREDLITE OUTER ROUNDEL
WITH 30° SPREDLITE OUTER ROUNDEL
TYPICAL BEAM COVERAGE

Figure 11. Compound lens system showing beam coverages with different lens combinations. Lens system shown viewed from side of signal; beam coverages shown looking down on track.

The spring has slotted sides. Slotting has the effect of dividing the spring into several similar springs, each one gripping the plug in a different place with a pressure of approximately 1-1/2 lbs., as shown.

D. The Optical System

The optical system of the compound-lens signal, Figure 11, consists of:

1. The lamp.
2. The reflector unit.
3. Color discs: red, yellow, green, or any other standard signal color.
4. The inner lens.
5. The outer lens.

Spreader and deflector roundels are added as required to shape the beam to the topography of the railroad. See Figures 11 and 13.

The stepped-lens signal, Figure 13, has the same units in the optical system, with the exception of the inner lens, which is replaced by a plain cover glass. The solid outer lens is replaced by a stepped lens. Outer lenses are 8-3/8 inches in diameter.

The plugboard in the housing is adjusted in the factory so that the inner lens or cover glass is at the proper distance from the outer lens to produce a parallel beam from the signal.

E. Why the Color Discs Are Slanted

It has been found that under certain conditions the signal light has been diluted by the light from the approaching engine's headlight. To create this condition it was necessary to have the headlight, signal, and the engineman's eyes on the same level.

This dilution created a weaker, paler aspect. Laboratory

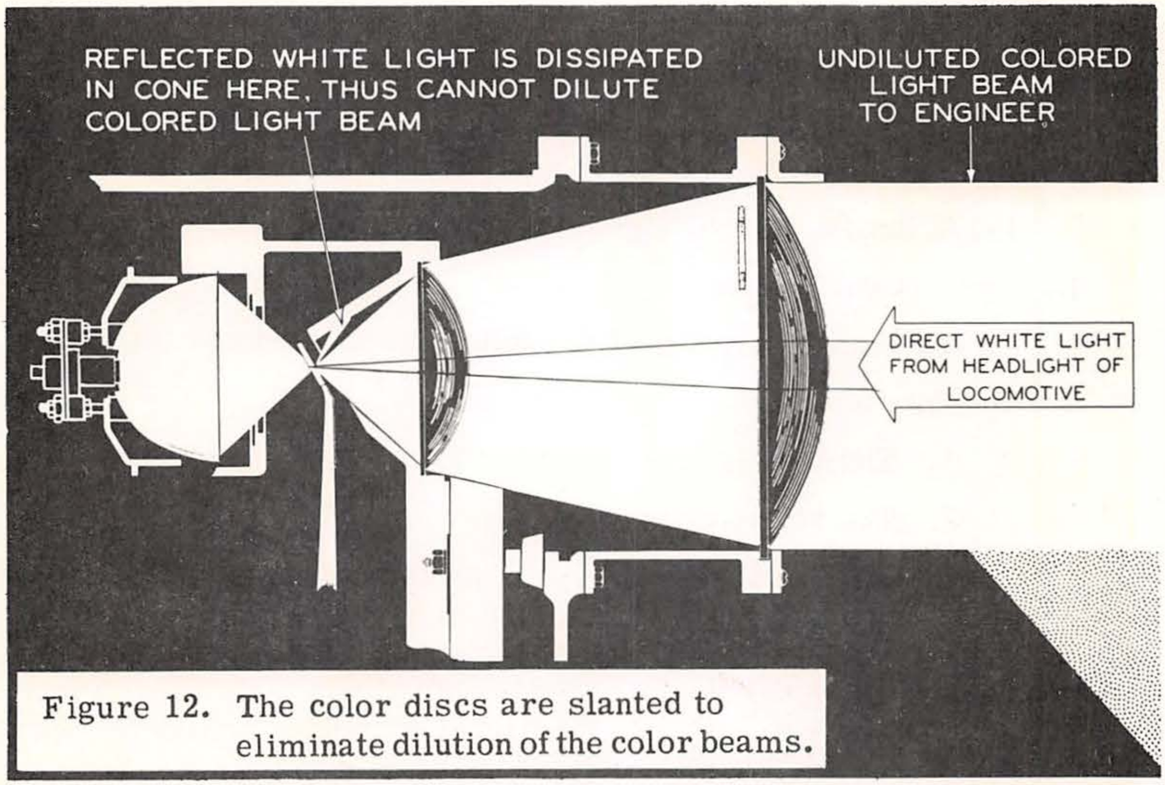

REFLECTED WHITE LIGHT IS DISSIPATED IN CONE HERE, THUS CANNOT DILUTE COLORED LIGHT BEAM
UNDILUTED COLORED LIGHT BEAM TO ENGINEER
DIRECT WHITE LIGHT FROM HEADLIGHT OF LOCOMOTIVE

Figure 12. The color discs are slanted to eliminate dilution of the color beams.

experiments proved that the direct white light from the headlight of a locomotive was concentrated on the mirror-like surface of the vertical color discs and was reflected to the engineman, mixed in with the signal beam, thus diluting the color.

In the SC signal the color discs are slanted away from the vertical so that extraneous light is now reflected upwards and into the serrated cone where it is absorbed. Thus the undiluted color beam is transmitted from the signal, Figure 12.

F. Lens Systems

Two basic lens systems are available:

1. The compound-lens system, consisting of two plano-convex lenses, having smooth surfaces on both sides, **Figure 11.**
2. The stepped-lens system, consisting of a single lens, which has a smooth, convex outer surface and concentric circular steps on the concave inner surface, Figure 13.

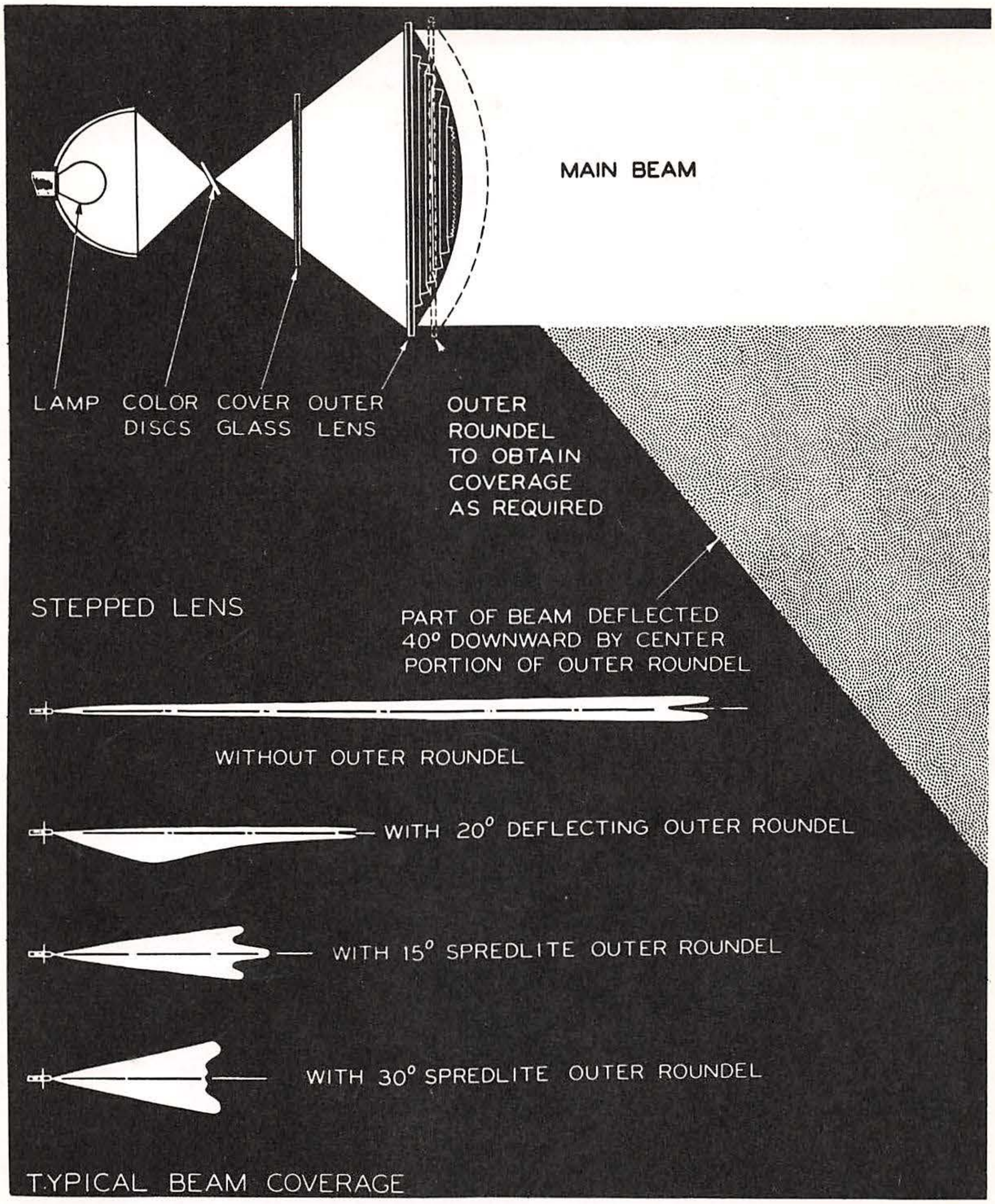

MAIN BEAM
LAMP
COLOR DISCS
COVER GLASS
OUTER LENS
OUTER ROUNDEL TO OBTAIN COVERAGE AS REQUIRED
STEPPED LENS
PART OF BEAM DEFLECTED 40° DOWNWARD BY CENTER PORTION OF OUTER ROUNDEL
WITHOUT OUTER ROUNDEL
WITH 20° DEFLECTING OUTER ROUNDEL
WITH 15° SPREDLITE OUTER ROUNDEL
WITH 30° SPREDLITE OUTER ROUNDEL
TYPICAL BEAM COVERAGE

Figure 13. Stepped lens system showing beam coverages with different lens combinations. Lens system shown viewed from side of signal; beam coverages shown looking down on track.

the HG (YELLOW) relay. In this way, a green aspect cannot be displayed unless the HG relay is energized.

When the HG ARMATURE is picked up, one end of the LINK is raised, imparting a clockwise rotating motion to the SPECTACLE BEAM and moving the SPECTACLE ARM far enough to the right to place the YELLOW color disc on the optical centerline of the signal, squarely in front of the lamp.

When the DG ARMATURE is picked up, the opposite end of the LINK is raised, imparting a further clockwise rotating motion to the SPECTACLE BEAM, moving the SPECTACLE ARM further to the right to place the GREEN color disc on the centerline of the signal, squarely in front of the lamp.

If the DG ARMATURE drops away, and HG ARMATURE remains picked up, the SPECTACLE ARM is rotated counterclockwise to produce a YELLOW aspect.

In the polar-neutral arrangement, both relays are energized by the same control circuit and, therefore, the HG ARMATURE drops only upon deenergization, in which event the DG ARMATURE also drops.

In the neutral-neutral relay arrangement, if the HG ARMATURE drops away, regardless of whether the DG ARMATURE is up or down, the SPECTACLE ARM rotates counterclockwise to the RED position, because the control of the DG relay is broken through the HG relay's front contacts.

When deenergized, the armatures rest on adjustable stop pins.

It will be noted, that aspects are displayed progressively, RED, then YELLOW, then GREEN (or vice versa), similar to a semaphore signal.

The contacts follow the position of the armature as in any conventional two-position relay; front contacts are made when the respective armature is picked up and back contacts when armature is dropped.

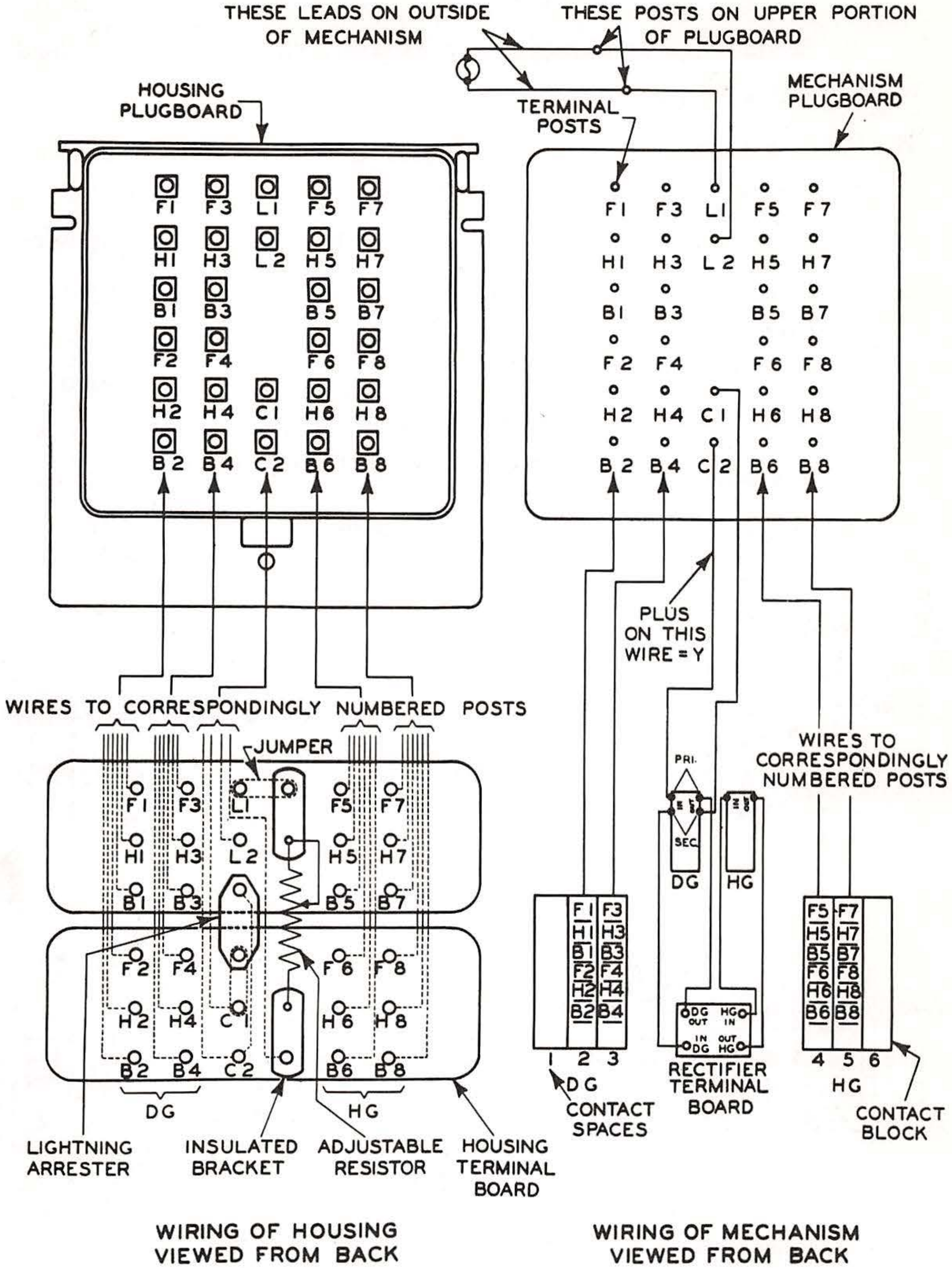

THESE LEADS ON OUTSIDE OF MECHANISM
THESE POSTS ON UPPER PORTION OF PLUGBOARD
HOUSING PLUGBOARD
TERMINAL POSTS
MECHANISM PLUGBOARD
F1 F3 L1 F5 F7
H1 H3 L2 H5 H7
B1 B3 B5 B7
F2 F4 F6 F8
H2 H4 C1 H6 H8
B2 B4 C2 B6 B8
PLUS ON THIS WIRE = Y
WIRES TO CORRESPONDINGLY NUMBERED POSTS
JUMPER
PRI.
SEC.
DG
HG
WIRES TO CORRESPONDINGLY NUMBERED POSTS
DG OUT
HG IN
IN DG
OUT HG
1 2 3
4 5 6
DG
HG
CONTACT SPACES
RECTIFIER TERMINAL BOARD
CONTACT BLOCK
LIGHTNING ARRESTER
INSULATED BRACKET
ADJUSTABLE RESISTOR
HOUSING TERMINAL BOARD
WIRING OF HOUSING VIEWED FROM BACK
WIRING OF MECHANISM VIEWED FROM BACK

Figure 15. Signal wiring diagram for standard polar-neutral mechanism.

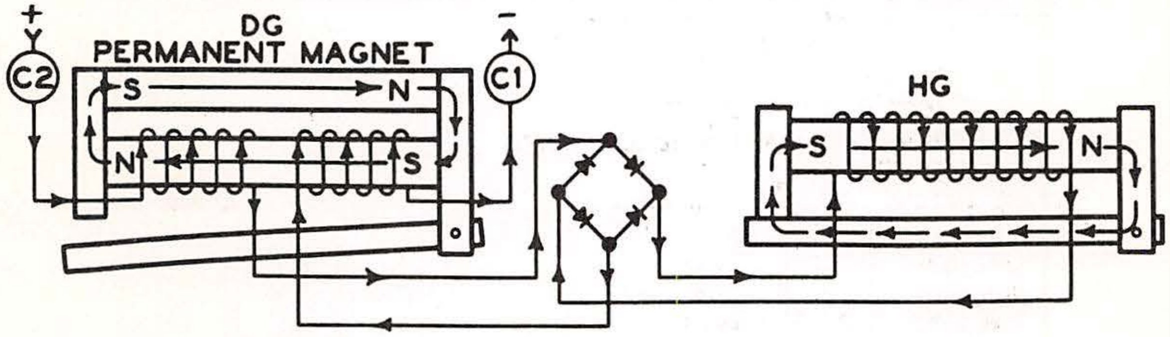
As previously stated, these relays have the same operating characteristics as standard d-c. relays; hence they may be made slow pickup and slow release.

H. Electrical Operation

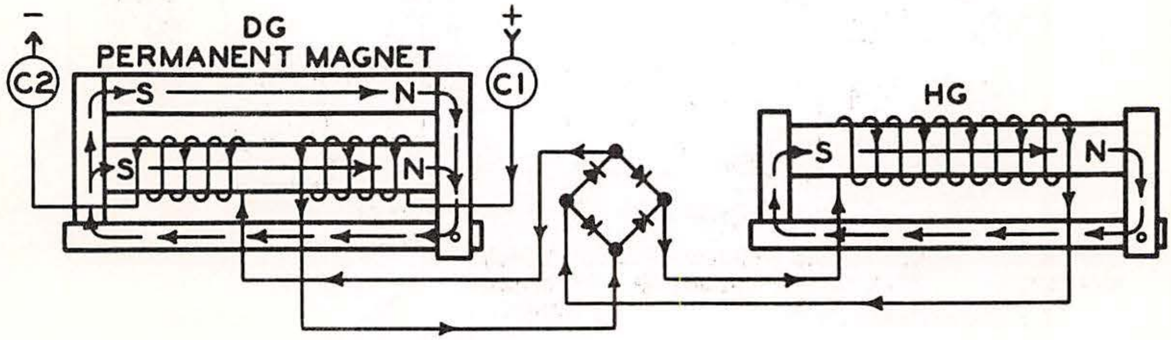
1. Standard polar-neutral mechanism

The standard polar-neutral mechanism and housing wiring, coils, plugboards, terminal board, etc., are shown in Figure 15.

Note in Figure 15 that the HG relay coil has one winding. This relay has slow-acting characteristics, sufficient to permit changing the polarity of its control circuit by a regular-acting relay without opening its front contacts. This is accomplished in part by the copper slugs provided on the



(a) Polarity applied to display YELLOW aspect.



(b) Polarity applied to display GREEN aspect.

Figure 16. Schematic diagrams of rectifier circuit for standard polar-neutral mechanism.

core and partially by means of the circuit arrangement incorporating the rectifier.

The DG relay coil has two windings. This coil is divided in this manner in order that the mechanism rectifier may be shielded from the line as a safeguard against lightning. One winding exists between each side of the line and the rectifier. The inherent characteristic of this relay is partial slow-acting. It is polarized by means of a permanent magnet incorporated in its magnetic structure.

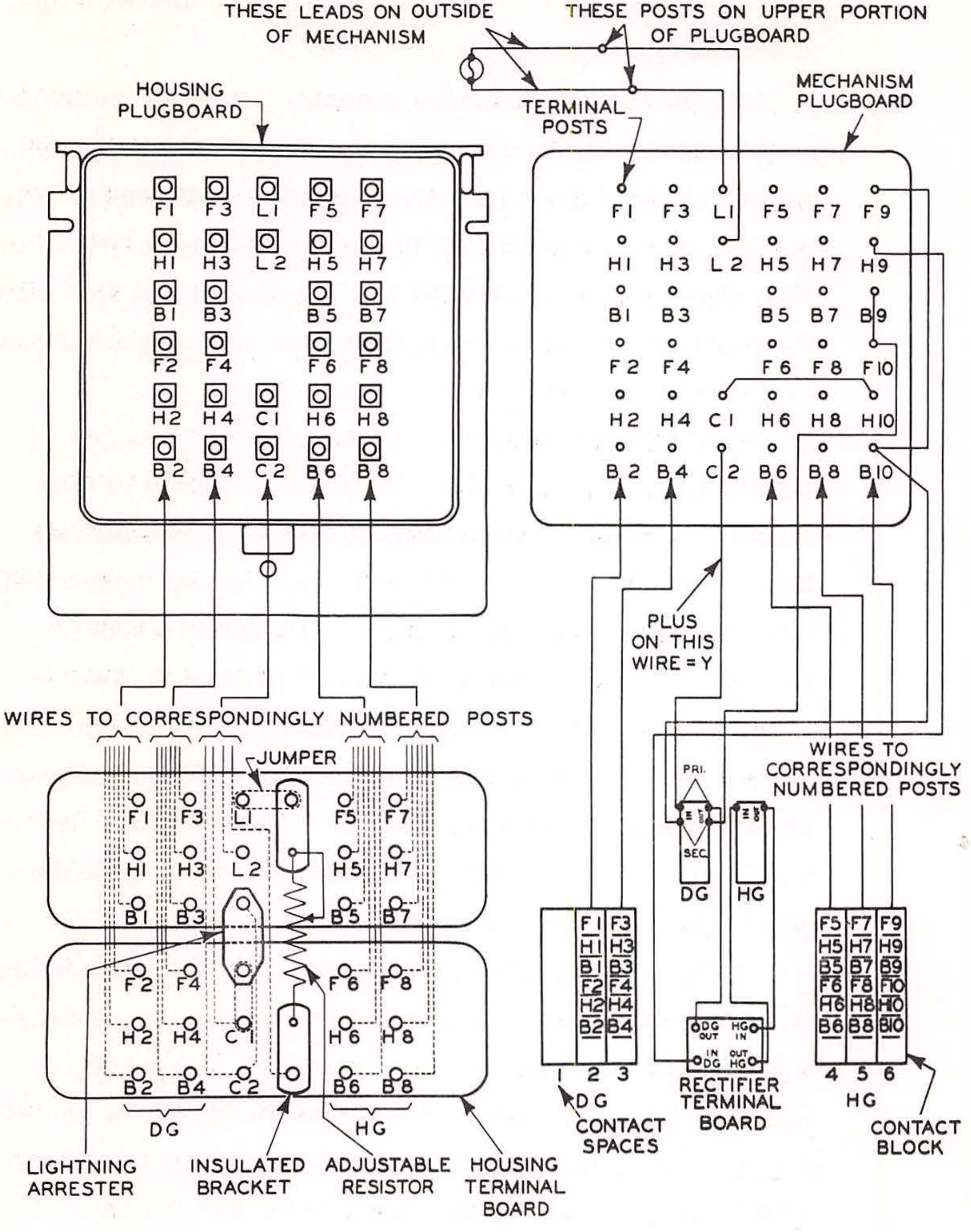
Upon initial energization, with (+) applied on plugboard terminal C1, see Figure 16(b), the flow of current is from terminal C1, through the secondary winding of the DG relay, through one path of the rectifier, through the HG relay winding, through another path of the rectifier, through the primary winding of the DG relay to terminal C2 and back to line (-).

This permits the HG relay to pick up, but, owing to the fact that an interlocking bar is attached to the DG armature, this relay is prevented from closing its front contacts before the HG armature has picked up. With both relays picked up, the GREEN aspect is displayed.

When energy is applied, (-) on terminal C1, the direction of the flow of current through the HG winding remains the same, but the direction of current flow through the DG winding is reversed. When current flow in this direction exists, the HG armature responds to energization, but the DG armature remains down or drops, as the case may be, and the signal indicates YELLOW.

2. Polar-neutral mechanism with slow-pickup and slow-release HG relay.

The polar-neutral arrangement can also be furnished


THESE LEADS ON OUTSIDE OF MECHANISM
THESE POSTS ON UPPER PORTION OF PLUGBOARD
HOUSING PLUGBOARD
TERMINAL POSTS
MECHANISM PLUGBOARD
F1 F3 L1 F5 F7
H1 H3 L2 H5 H7
B1 B3 B5 B7
F2 F4 F6 F8
H2 H4 C1 H6 H8
B2 B4 C2 B6 B8
F1 F3 L1 F5 F7 F9
H1 H3 L2 H5 H7 H9
B1 B3 B5 B7 B9
F2 F4 F6 F8 F10
H2 H4 C1 H6 H8 H10
B2 B4 C2 B6 B8 B10
PLUS ON THIS WIRE = Y
WIRES TO CORRESPONDINGLY NUMBERED POSTS
JUMPER
WIRES TO CORRESPONDINGLY NUMBERED POSTS
PRI.
SEC.
DG
HG
DG OUT
HG IN
IN DG
OUT HG
1 2 3
DG
CONTACT SPACES
RECTIFIER TERMINAL BOARD
4 5 6
HG
CONTACT BLOCK
LIGHTNING ARRESTER
INSULATED BRACKET
ADJUSTABLE RESISTOR
HOUSING TERMINAL BOARD

WIRING OF HOUSING VIEWED FROM BACK

WIRING OF MECHANISM VIEWED FROM BACK

Figure 17. Signal wiring diagram for polar-neutral mechanism with slow-pickup and slow-release HG relay.

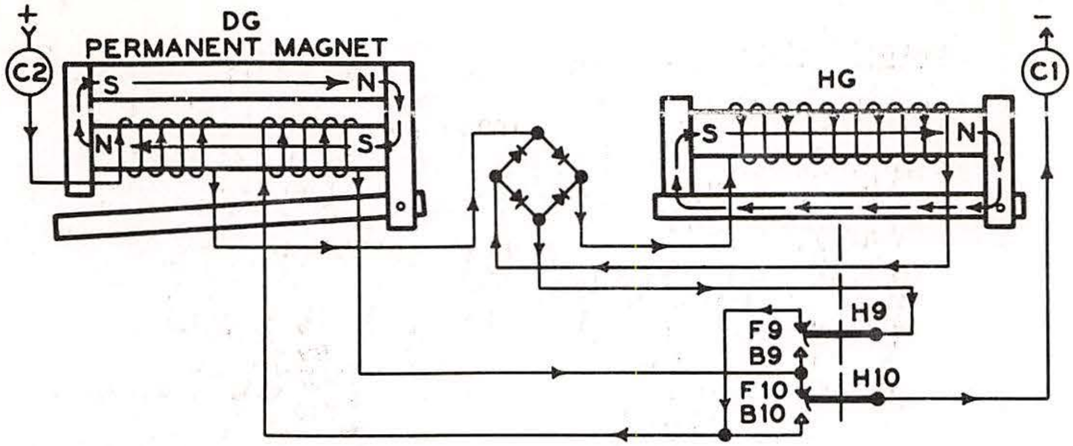
designed for slow pickup and slow release of the HG relay. For this arrangement the mechanism and housing wiring, coils, plugboards, terminal board, etc., are shown in Figure 17. Since the DG relay is relatively quick acting, it is necessary to interlock its operation with that of the HG relay to provide proper sequence of operation when GREEN polarity is applied with windings deenergized. The interlocking bar of the standard polar-neutral arrangement is supplanted by an electrical interlock through an extra set of make-before-break pole-changing contacts on the HG relay, so that the pickup timing of the HG relay is not influenced by the quicker action of the DG armature. These contacts are connected internally and do not have leads brought out separately to the plugboard.

When the pole-changing contacts are made in the back position only, the two halves of the DG coil buck each other, preventing pickup of the armature. When the HG relay picks up, thus closing the front contacts, the two halves of the DG coil work together thus permitting pickup of the armature (if the polarity applied is that predetermined to give the green aspect).

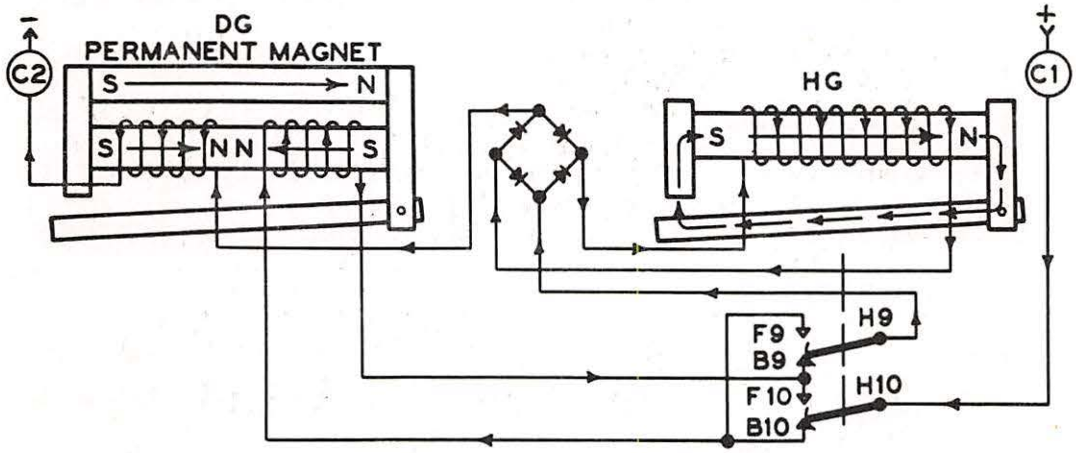
Except for the addition of the interlocking contacts, the operation of the circuit is the same as described for the standard polar-neutral arrangement. The circuit may be readily traced out in Figure 18.

3. Neutral-neutral mechanism

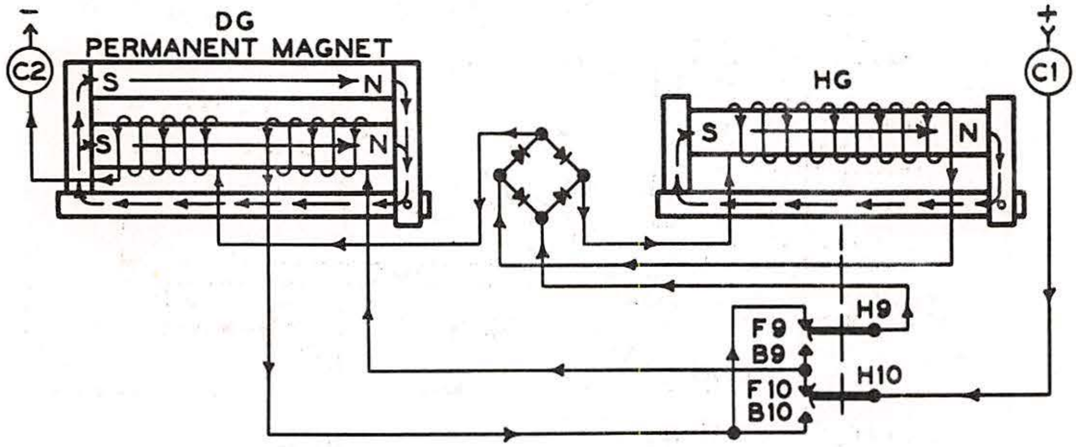
The neutral-neutral mechanism and housing wiring is shown in Figure 19. The HG relay is connected to terminals C3 and C4. The DG relay is connected to terminals C1 and C2.


+
DG
PERMANENT MAGNET
C2
S
N
N
S
HG
S
N
C1
−
H9
F9
B9
F10
B10
H10

(a) Polarity applied to display YELLOW aspect. Shown after HG relay has picked up.


−
DG
PERMANENT MAGNET
C2
S
N
S
N N
S
HG
S
N
+
C1
H9
F9
B9
F10
B10
H10

(b) Shown at instant current is applied with polarity to display GREEN aspect - - just before HG picks up. Note how coils of DG buck each other and prevent DG from picking up until HG front contacts are made.


−
DG
PERMANENT MAGNET
C2
S
N
S
N
HG
S
N
+
C1
H9
F9
B9
F10
B10
H10

(c) Shown with polarity applied to display GREEN aspect. Both relays have now picked up.

Figure 18. Schematic diagrams of rectifier circuit for polar-neutral mechanism with slow-pickup and slow-release HG relay.

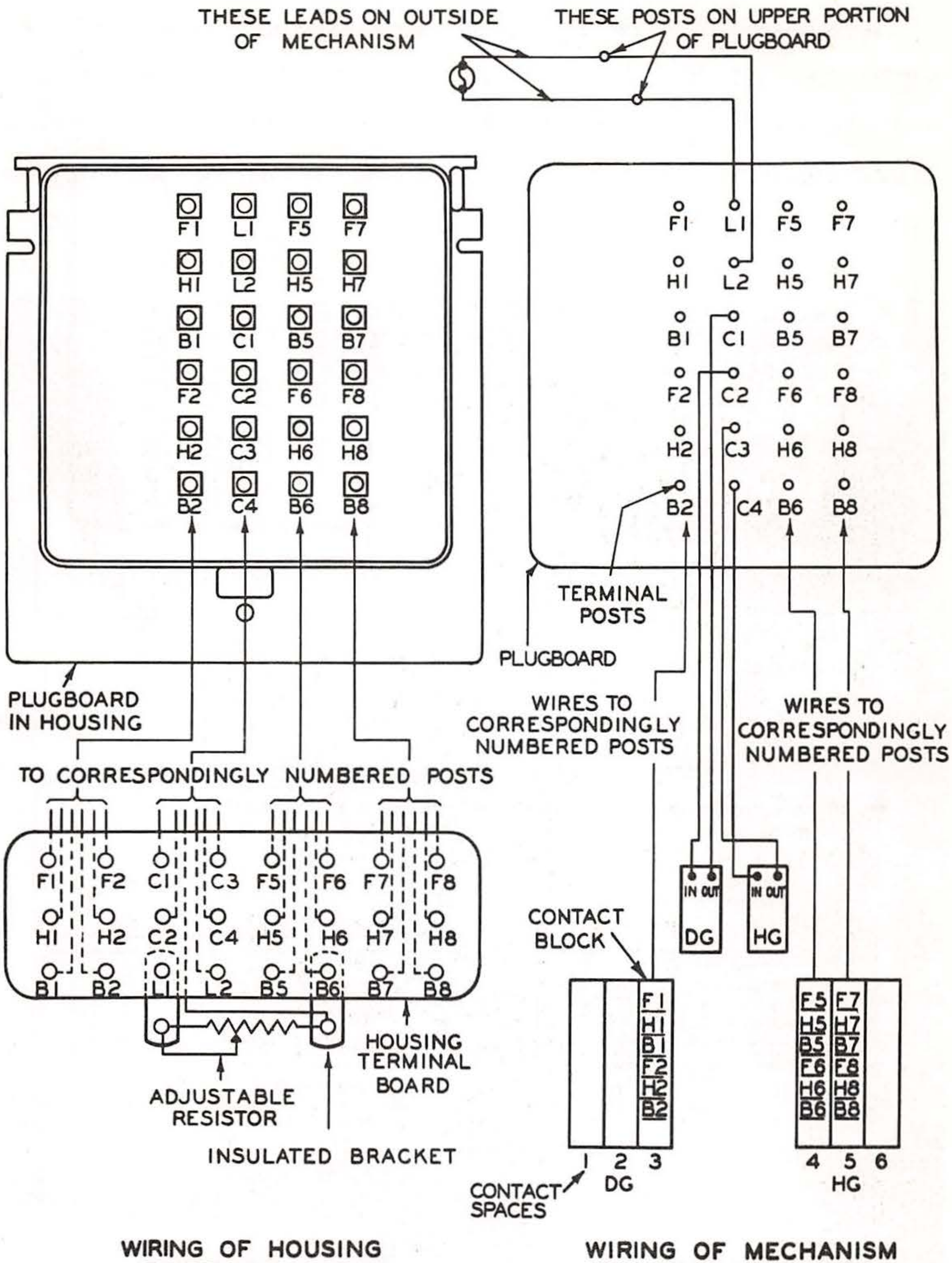

THESE LEADS ON OUTSIDE OF MECHANISM
THESE POSTS ON UPPER PORTION OF PLUGBOARD
F1 L1 F5 F7
H1 L2 H5 H7
B1 C1 B5 B7
F2 C2 F6 F8
H2 C3 H6 H8
B2 C4 B6 B8
PLUGBOARD IN HOUSING
TO CORRESPONDINGLY NUMBERED POSTS
F1 F2 C1 C3 F5 F6 F7 F8
H1 H2 C2 C4 H5 H6 H7 H8
B1 B2 L1 L2 B5 B6 B7 B8
ADJUSTABLE RESISTOR
HOUSING TERMINAL BOARD
INSULATED BRACKET
TERMINAL POSTS
PLUGBOARD
WIRES TO CORRESPONDINGLY NUMBERED POSTS
WIRES TO CORRESPONDINGLY NUMBERED POSTS
IN OUT
DG
IN OUT
HG
CONTACT BLOCK
F1 H1 B1 F2 H2 B2
F5 F7 H5 H7 B5 B7 F6 F8 H6 H8 B6 B8
1 2 3
DG
4 5 6
HG
CONTACT SPACES
WIRING OF HOUSING VIEWED FROM BACK
WIRING OF MECHANISM VIEWED FROM BACK

Figure 19. Signal wiring diagram for neutral-neutral mechanism.

It is obvious that the mechanism wiring and housing wiring must agree, hence, a number appears in the upper left-hand corner of the name plate attached to each mechanism and housing. When inserting a mechanism in a housing, it should be ascertained that these numbers agree, as illustrated in Figure 20.

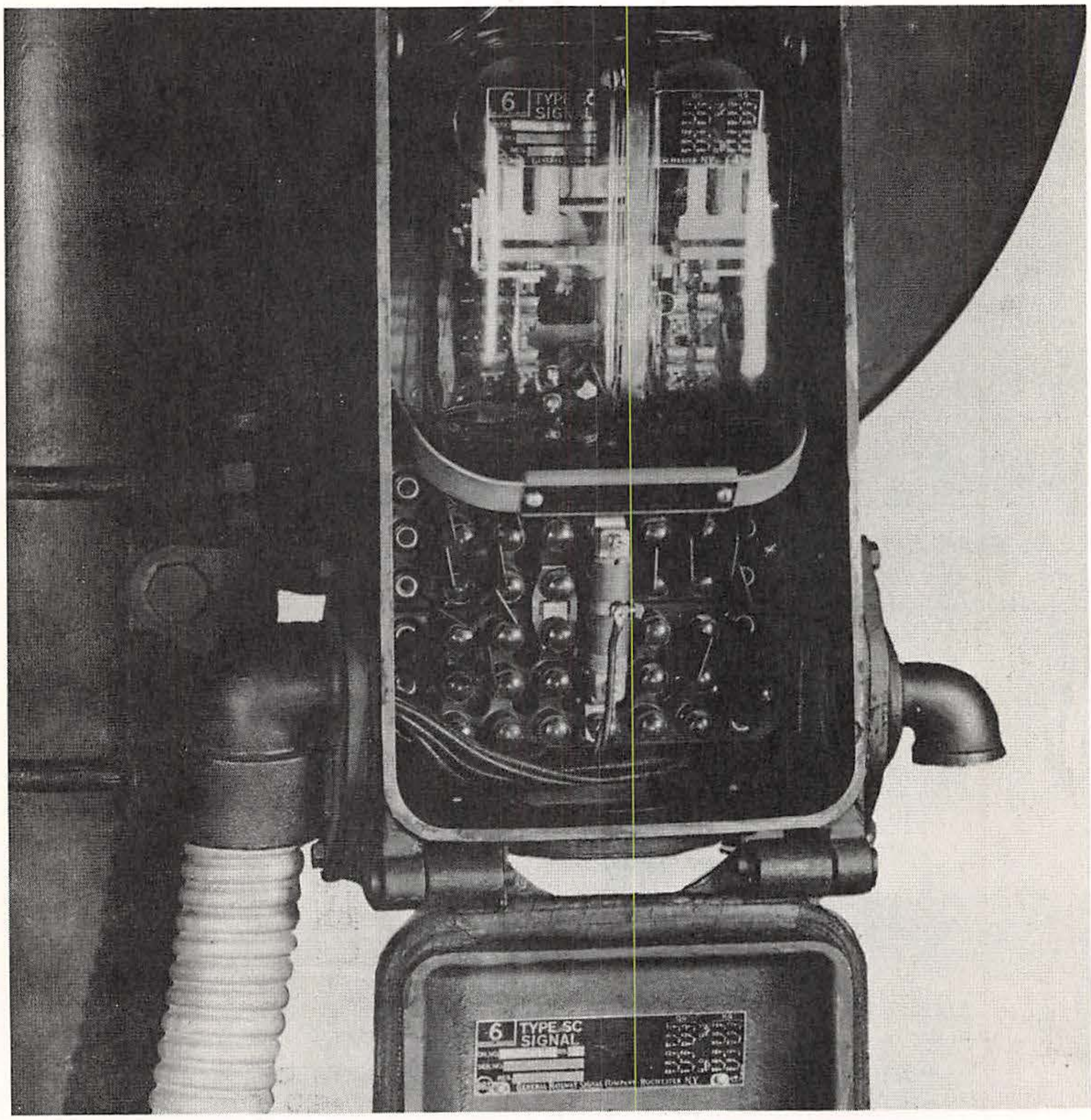


Figure 20. Circuit numbers on mechanism and on housing name plates must agree.

III. INSTALLATION AND MAINTENANCE

To obtain the best results, the signal should be so located with respect to the track that the lens is as nearly as possible on a level with the eyes of the engineman and as close to the track as clearances will permit. It will be found that this condition normally calls for mounting the signal on the left-hand side of the mast as viewed by the approaching engineman.

Before mounting the signal housing, a check should be made to determine if the signal has the required outer roundel to cover track curvature. The effect of these roundels is shown in Figures 11 and 13. They are described fully in Pamphlet 530, "How to Select the Proper Optical Combination for any Given Condition."

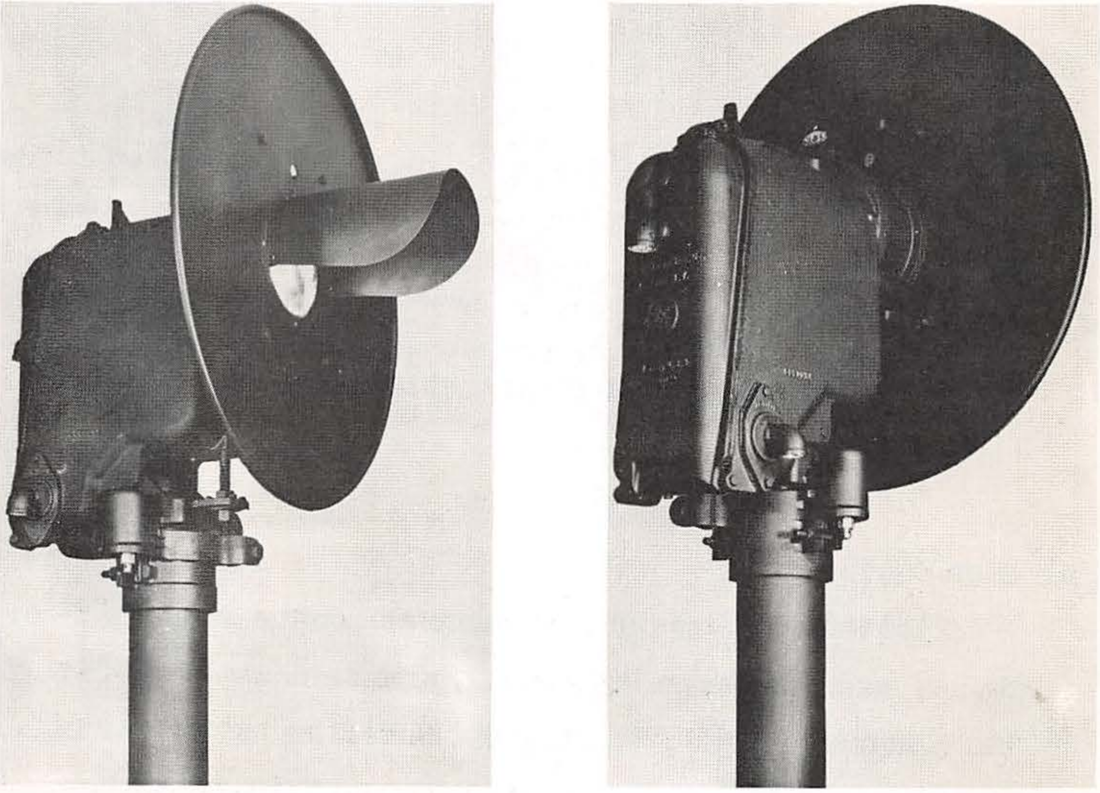


Figure 21. Side and rear views of Type SC signal mounted on top of mast with resilient mounting.

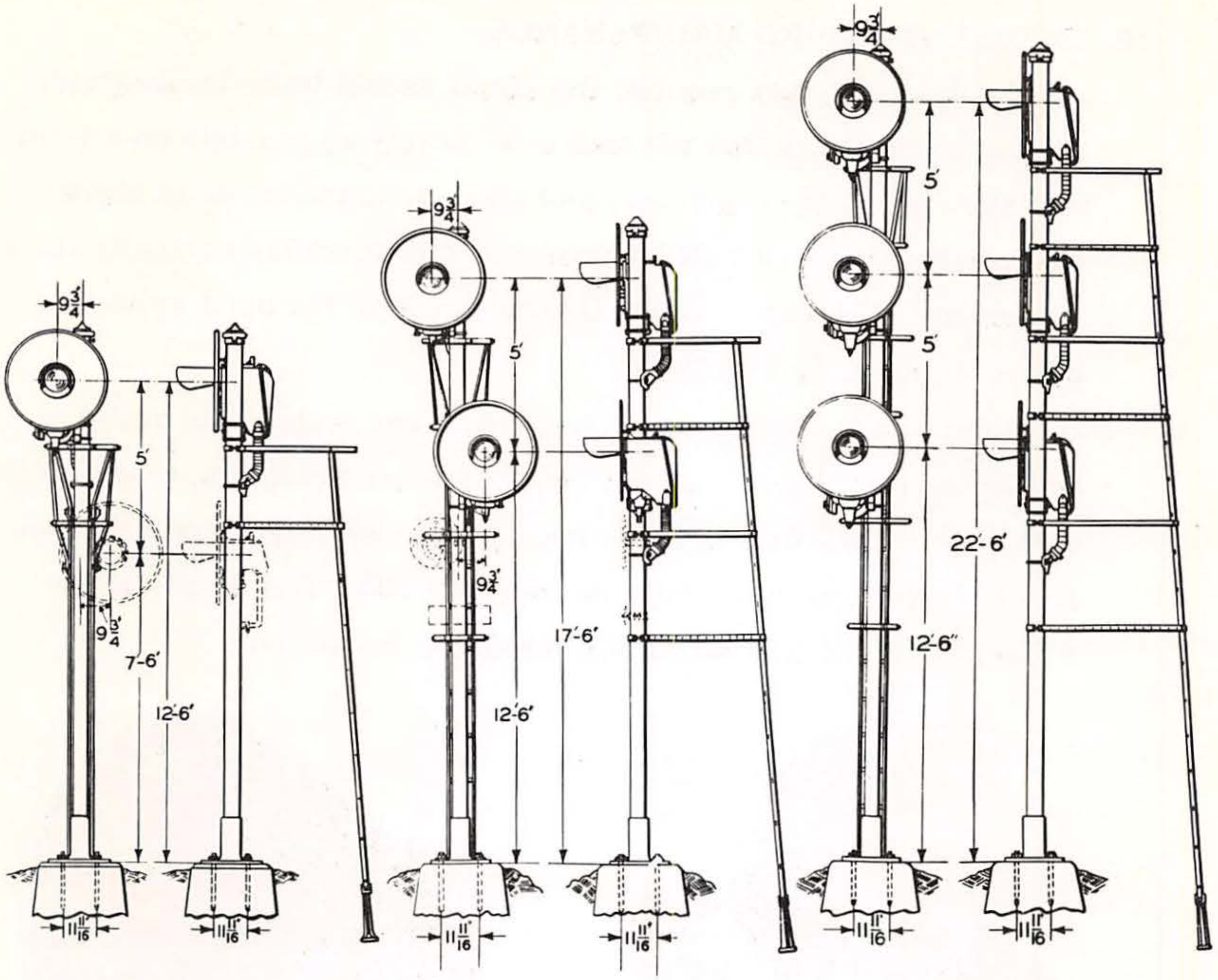
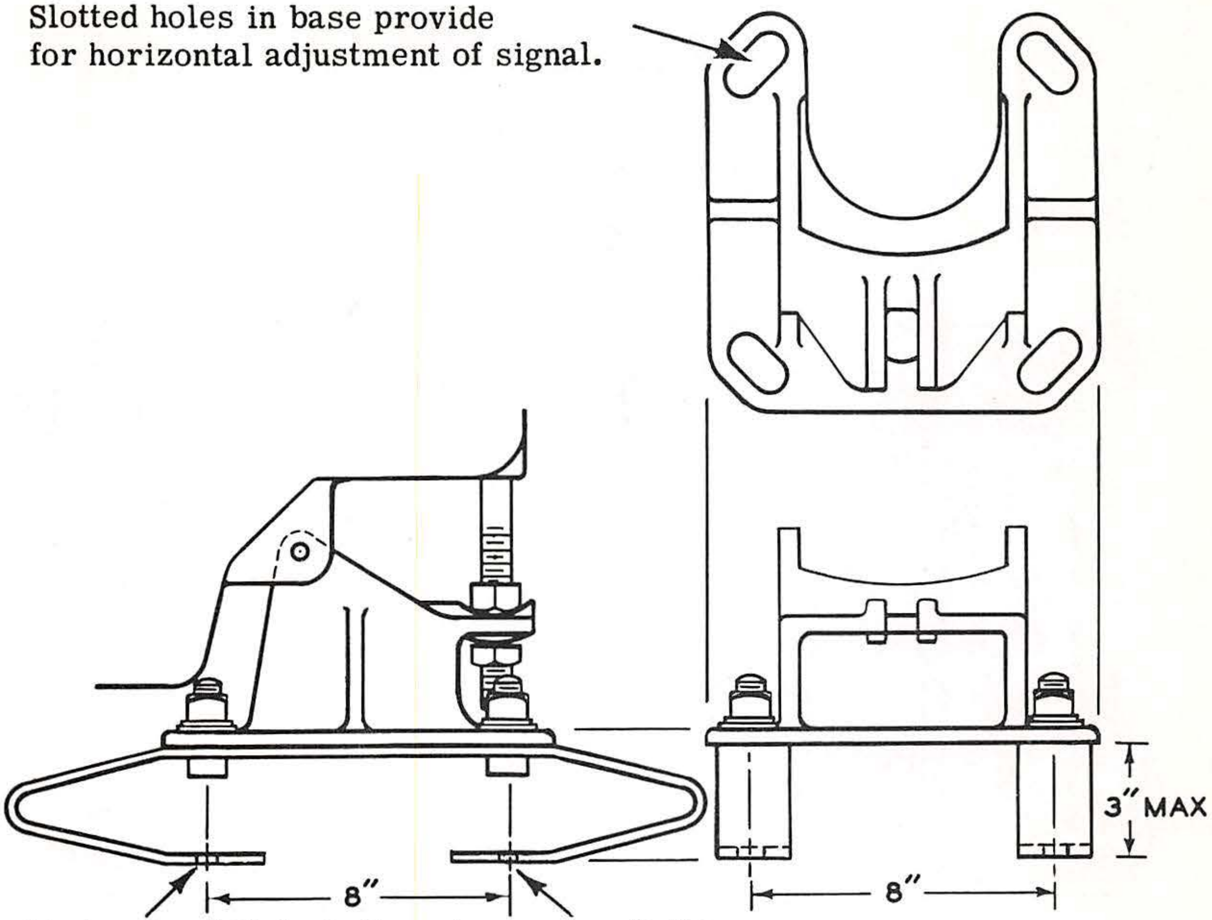

9 3/4
9 3/4
9 3/4
5'
5'
5'
5'
9 3/4
9 3/4
7-6'
12-6'
17-6'
12-6'
22-6'
12-6"
11 11/16
11 11/16
11 11/16
11 11/16
11 11/16
11 11/16

Figure 22. Some typical arrangements of Type SC signals. 9-3/4-inch distance shown from center of lens to centerline of mast is for 5-inch mast; with 6-inch mast, this distance is 10-1/2 inches.

A. High Signals

Type SC high signals can be mounted on the side of a 5- or 6-inch mast, as shown in Figure 1, or on top, as shown in Figure 21. When mounted on the side, the centerline of the lens is 9-3/4 inches from the centerline of a 5-inch mast (10-1/2 inches for a 6-inch mast). The height above the top of the foundation may vary on different railroads. Typical dimensions are given in Figure 22.


Slotted holes in base provide
for horizontal adjustment of signal.

4 holes for 3/4-inch diameter anchor bolts

Figure 23. Spring-mounted base for dwarf signal or for bridge signal.

The side-of-mast mounting bracket is shown in Figure 28. The top-of-mast socket is shown in Figure 29.

The high signal complete with its mechanism and bracket for top-of-mast mounting weighs approximately 230 pounds, with side-of-mast mounting bracket, approximately 240 pounds.

B. Bridge Signals

Type SC bridge signals are either fastened to the bridge girders or to masts which are anchored to the girders. In the latter case the brackets shown in Figures 28 and 29 can be used.

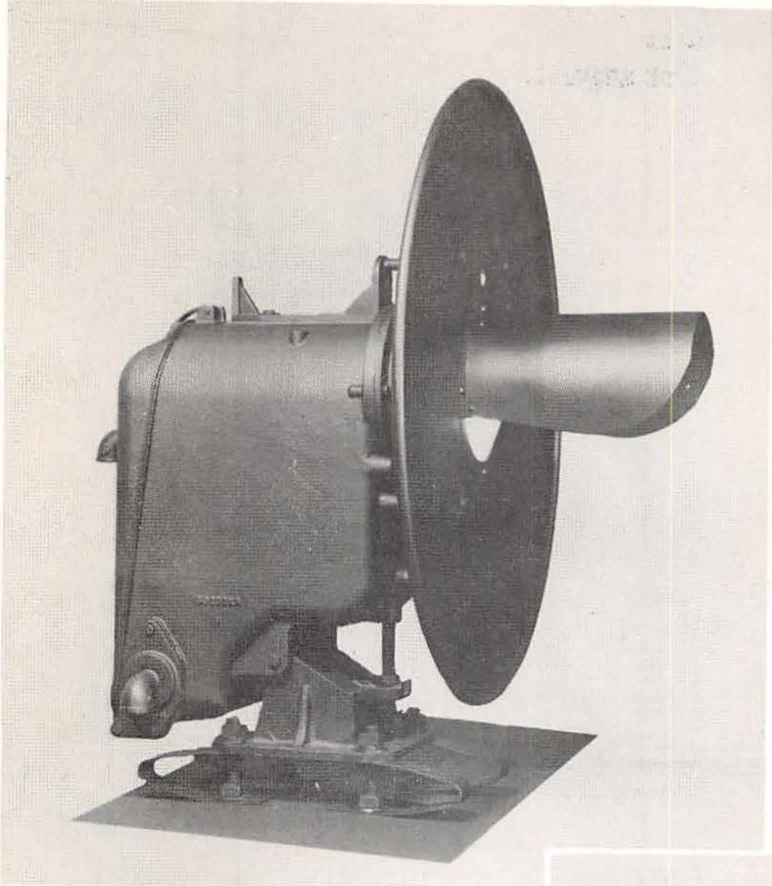
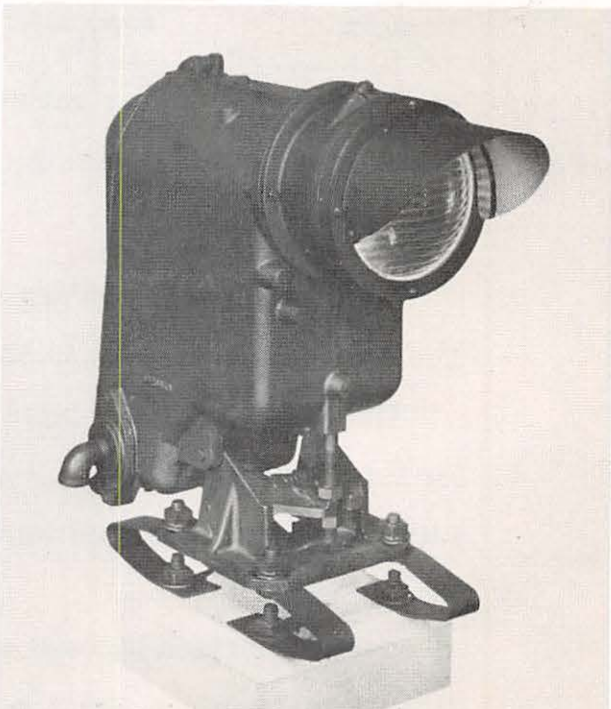


Figure 24.
Type SC bridge signal as arranged for bolting to bridge plate.

Figure 25.
Type SC one-arm dwarf signal with outer deflecting roundel.



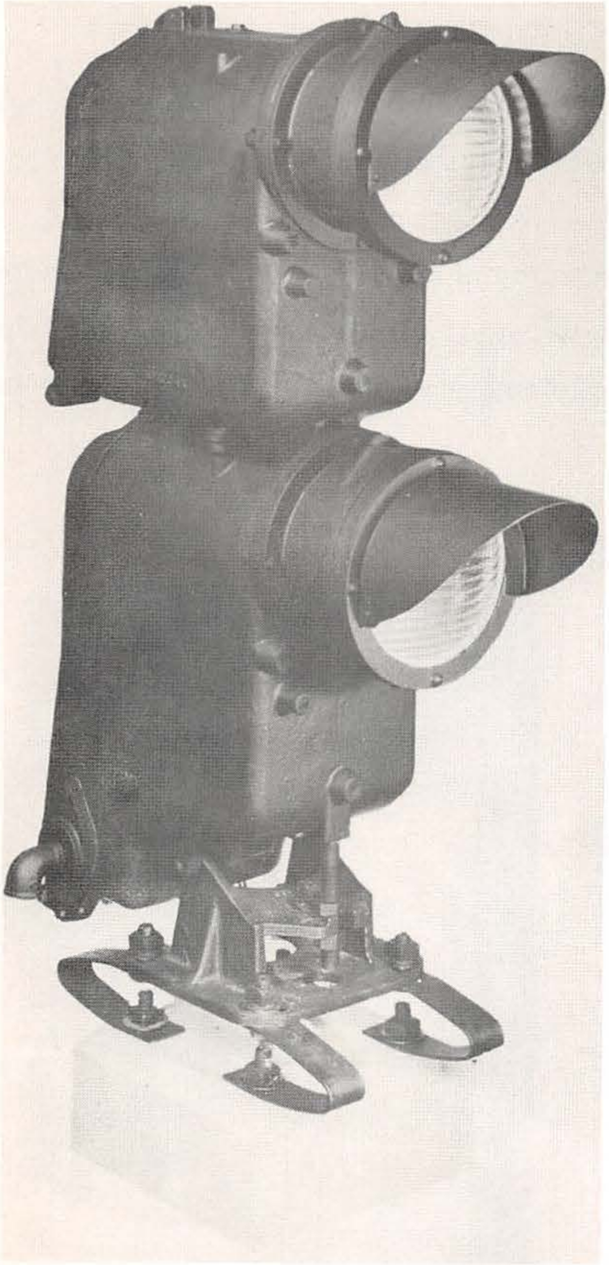


Figure 26. Type SC two-arm dwarf signal with outer deflecting roundels.

When the signals are mounted on the girders, a spring-mounted base, Figure 23, is furnished. Holes are slotted in this base to provide some lateral adjustment when aligning the signal. Figure 24 shows the spring-mounted bridge signal complete.

The bridge signal complete with mechanism and spring-mounted base weighs approximately 220 pounds.

C. Dwarf Signals

Type SC dwarf signals are of the one-arm and two-arm types. The one-arm signal is shown in Figure 25; the two-arm in Figure 26. These signals are provided with spring-mounted bases as shown.

Dwarf signals are usually equipped with outer roundels to deflect the beam upward to the engineman. An arrow cast in the roundel indicates the direction in which the beam is deflected.

The one-arm dwarf signal with its mechanism and spring-mounted base weighs approximately 200 pounds. The two-arm signal complete with its mechanism and spring-mounted base weighs approximately 355 pounds.

D. Heights of Dwarf Signals

1. One arm:

From top of foundation to top of housing	28-1/2 inches
From top of foundation to center of lens	23-3/16 inches

2. Two-arm:

From top of foundation to top of housing	46-3/16 inches
From top of foundation to center of lower lens	23-3/16 inches
From top of foundation to center of upper lens	41-3/16 inches

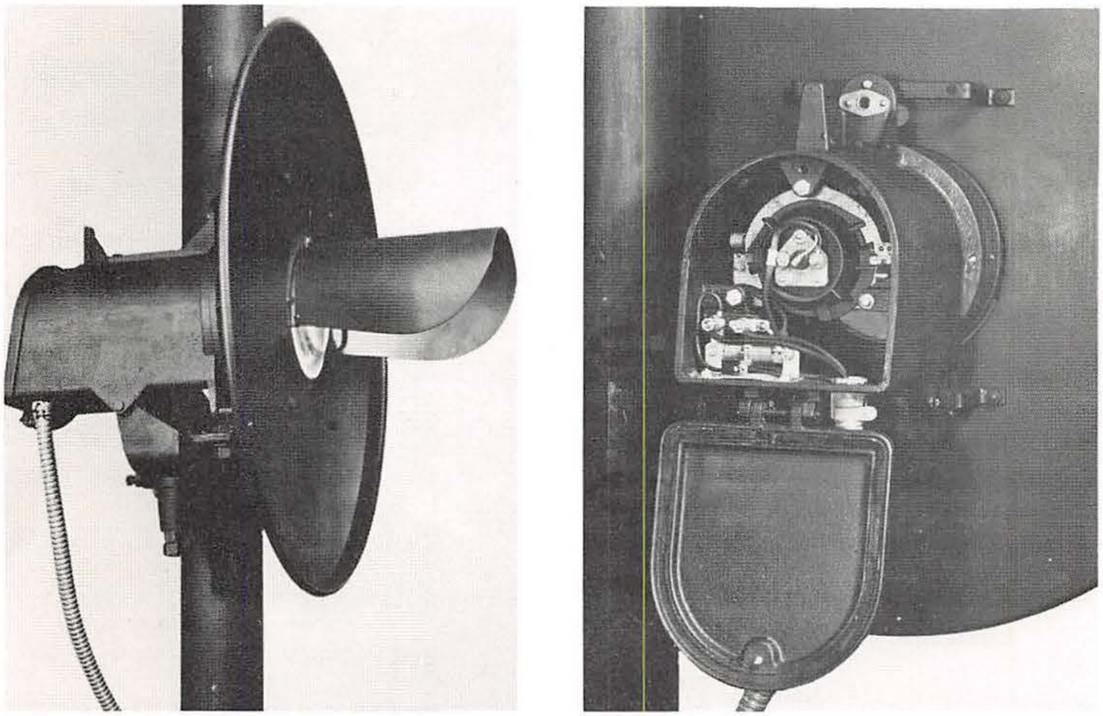


Figure 27. Type SC fixed signal, side and rear views. Rear view shows terminal board, adjustable lamp resistor, and detachable lamp socket and reflector unit.

E. Fixed Signals

Type SC fixed signals, Figure 27, are used to provide an aspect of one color only. They are equipped with either the compound lens (as shown) or the stepped lens and are furnished for mounting on bridge or mast, as specified. Resilient mountings are not required for fixed signals.

The rear view of the signal shows the cover open. A single fixed slanted color disc is used; otherwise the optical system is the same as that used in the Type SC operative signals, Figures 11 and 13. The rear door can be opened with a standard 1/2-inch socket wrench.

The fixed signal complete with background and mounting bracket as shown weighs approximately 123 pounds.

F. Mounting the Signal Housing

Referring to Figure 28, the side-of-mast signal may be assembled either with its mounting bracket and the signal put in place together, or the bracket may be attached to the mast and the signal housing, then assembled in place. In the latter case, after the bracket has been attached to the mast by means of the U-bolts, all that is necessary to mount the housing is to remove the nuts for locking horizontal adjustment from the bottom of the stud, drop the stud through the vertical pivot hole in the bracket, and replace the nuts.

In cases where flexible conduit is used for the wires from the mast to the signal, care must be used in locating the bracket on the mast to insure its proper location in relation to the conduit opening in the mast.

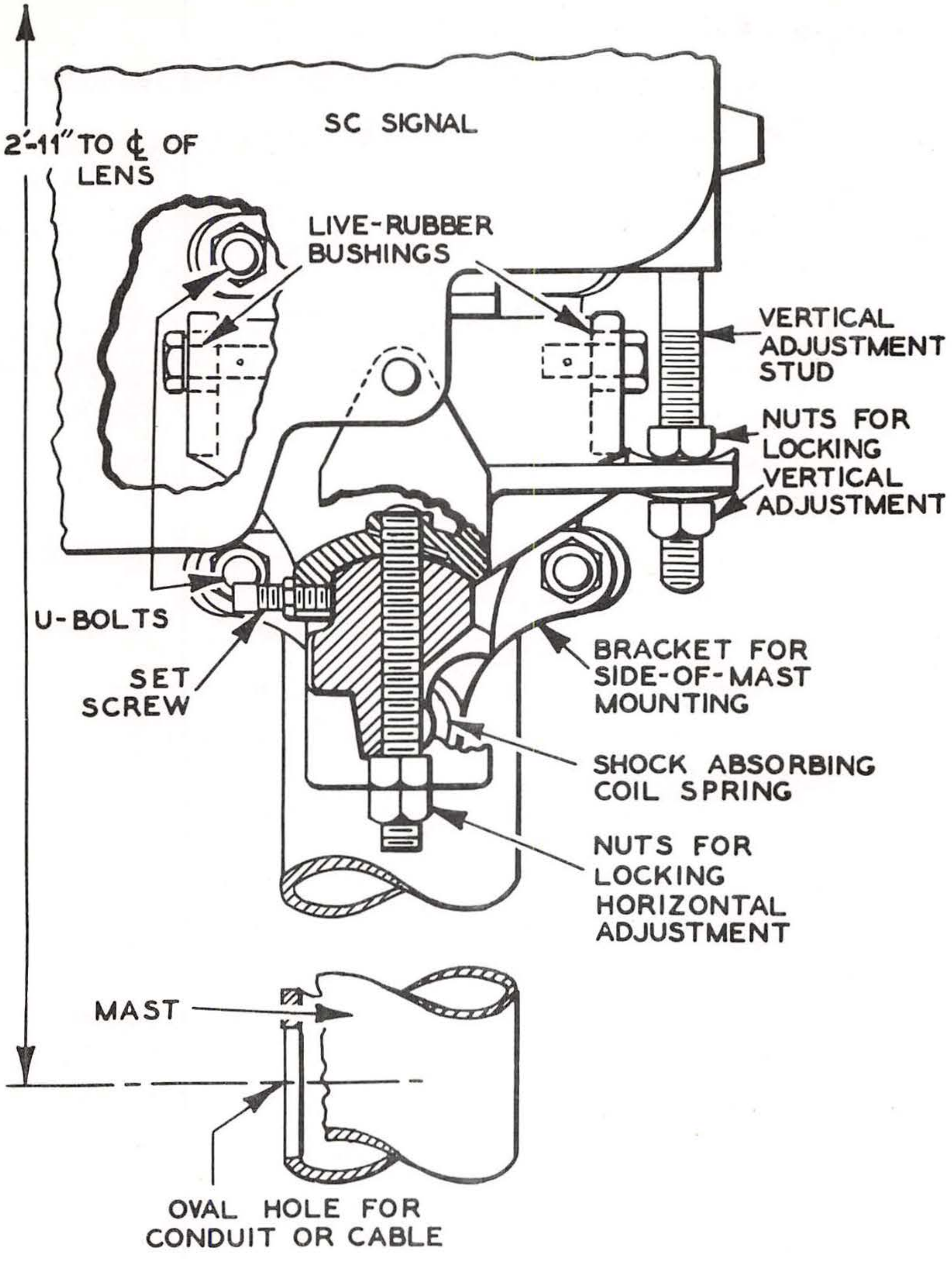

SC SIGNAL
2'-11" TO ℄ OF LENS
LIVE-RUBBER BUSHINGS
VERTICAL ADJUSTMENT STUD
NUTS FOR LOCKING VERTICAL ADJUSTMENT
U-BOLTS
SET SCREW
BRACKET FOR SIDE-OF-MAST MOUNTING
SHOCK ABSORBING COIL SPRING
NUTS FOR LOCKING HORIZONTAL ADJUSTMENT
MAST
OVAL HOLE FOR CONDUIT OR CABLE

Figure 28. Horizontal and vertical adjustments for side-of-mast mounting bracket.

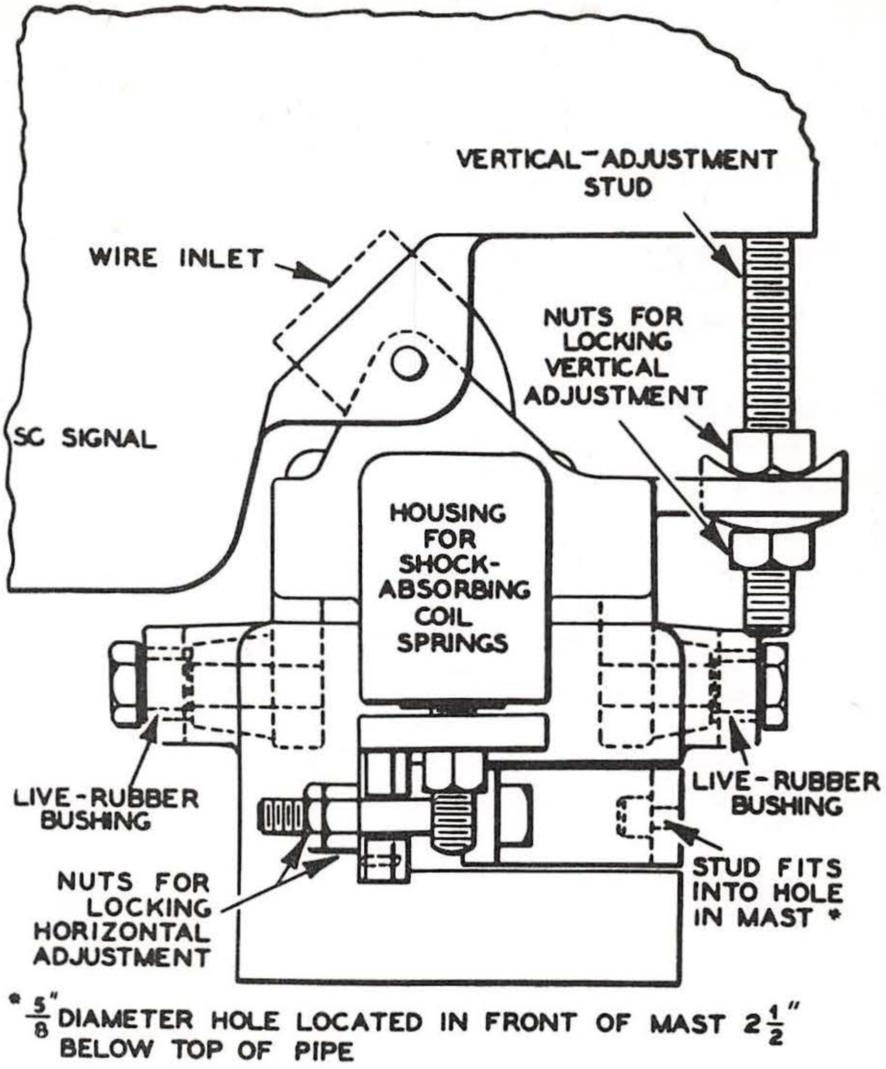
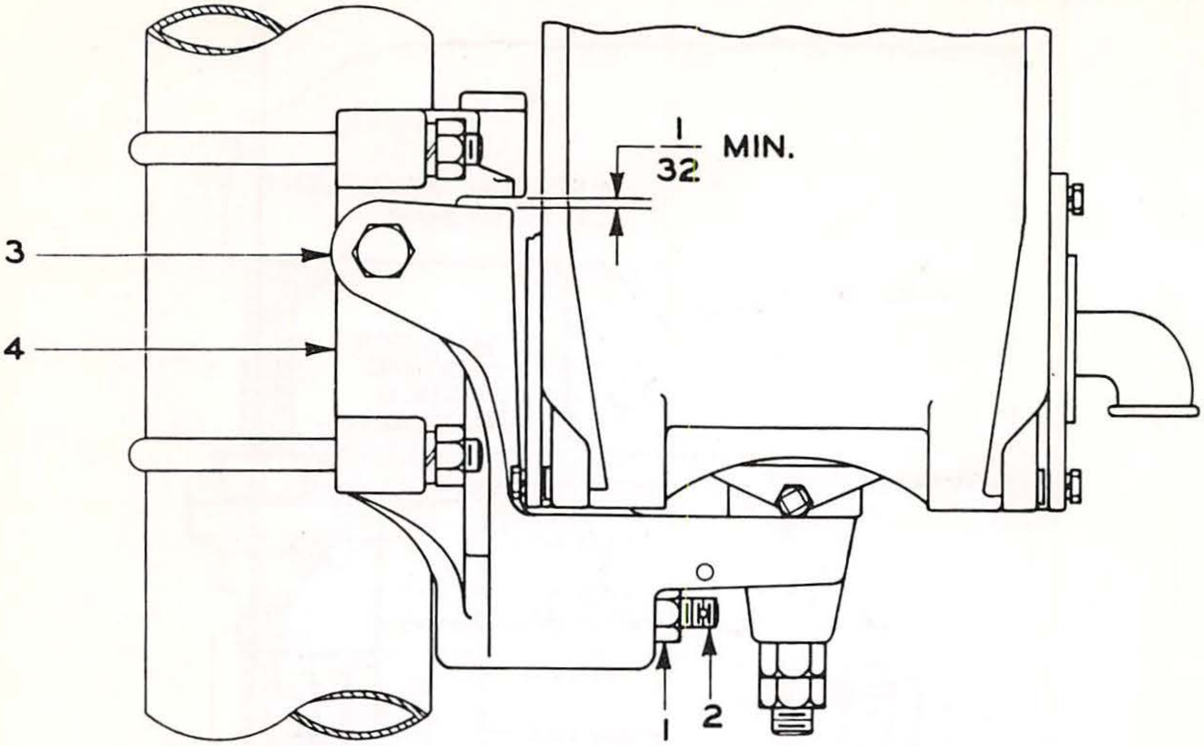

VERTICAL-ADJUSTMENT STUD
WIRE INLET
NUTS FOR LOCKING VERTICAL ADJUSTMENT
SC SIGNAL
HOUSING FOR SHOCK-ABSORBING COIL SPRINGS
LIVE-RUBBER BUSHING
LIVE-RUBBER BUSHING
NUTS FOR LOCKING HORIZONTAL ADJUSTMENT
STUD FITS INTO HOLE IN MAST *
* 5/8" DIAMETER HOLE LOCATED IN FRONT OF MAST 2 1/2" BELOW TOP OF PIPE

Figure 29. Horizontal and vertical adjustments for top-of-mast mounting bracket.

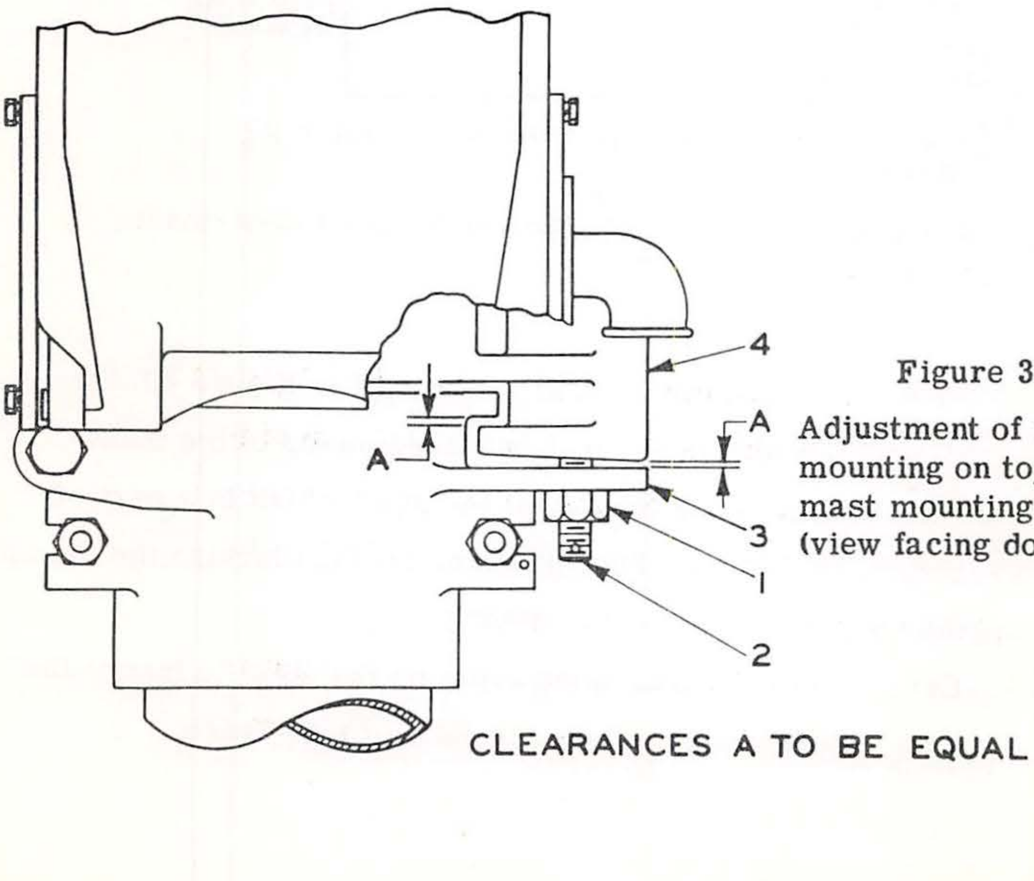
For top-of-mast mounting, illustrated in Figure 29, the signal housing with the socket is placed on top of the mast. Then the clamp is placed so that the stud, which is a part of the clamp, fits into the hole in the mast, thus locking the clamp in place when the nuts are tightened.

Care should be taken when erecting the mast to insure that the hole is located correctly in relation to the track.



$\frac{1}{32}$ MIN.
3
4
1
2

Figure 30. Adjustment of resilient mounting on side-of-mast mounting bracket (view facing door).



4
A
A
3
1
2
CLEARANCES A TO BE EQUAL

Figure 31.

Adjustment of resilient mounting on top-of-mast mounting bracket (view facing door).

G. Adjustment of Resilient Mountings

1. Side-of-mast, Figure 30.

After the housing has been installed on the pole complete with mechanism, hood, background, and conduit coupling attached, adjust the resilient mounting bracket as follows, referring to Figure 30:

(a) Loosen lock nut 1.

(b) Turn stud 2 clockwise or counterclockwise as required to align signal housing parallel to pole. (Holes are provided in stud to insert 1/8-inch rod or nail for turning.)

(c) Check clearance between castings 3 and 4 at point shown. This clearance must be 1/32 inch minimum. If necessary, back off stud to obtain clearance, even if signal housing does not stand quite vertically.

(d) Lock stud in position with nut 1.

NOTE: Adjustment may be sealed with car seal threaded through hole in stud 2 and hole in casting 3, if desired.

2. Top-of-mast, Figure 31.

After the housing has been installed on the pole complete with mechanism, hood, and background, adjust the resilient mounting bracket as follows, referring to Figure 31:

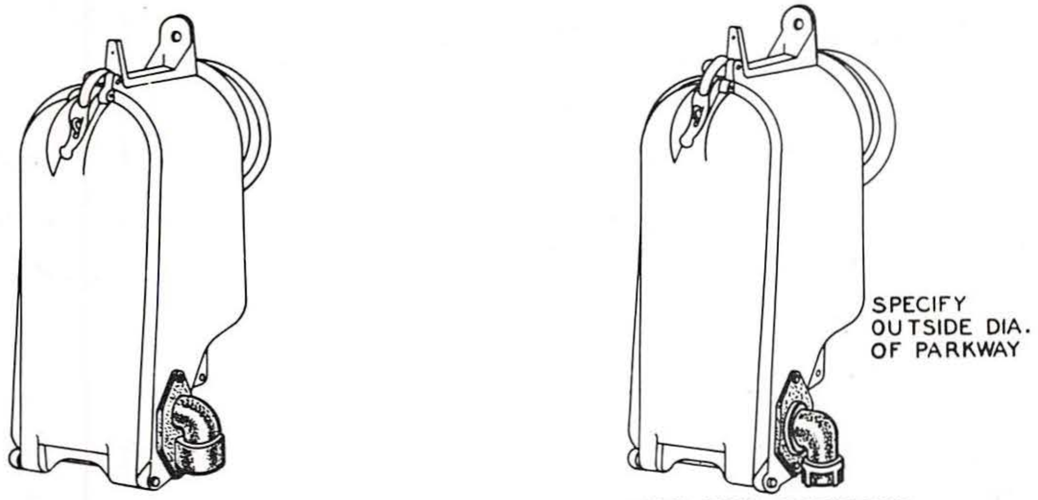
(a) Loosen lock nut 1.

(b) Turn stud 2 clockwise or counterclockwise as required to align signal housing with pole. (Holes are provided in stud to insert 1/8-inch rod or nail for turning.)

(c) Check clearances between castings 3 and 4 at points shown. These clearances shall be approximately even. If necessary, adjust stud to obtain equalized clearances, even if signal housing does not stand quite vertically.

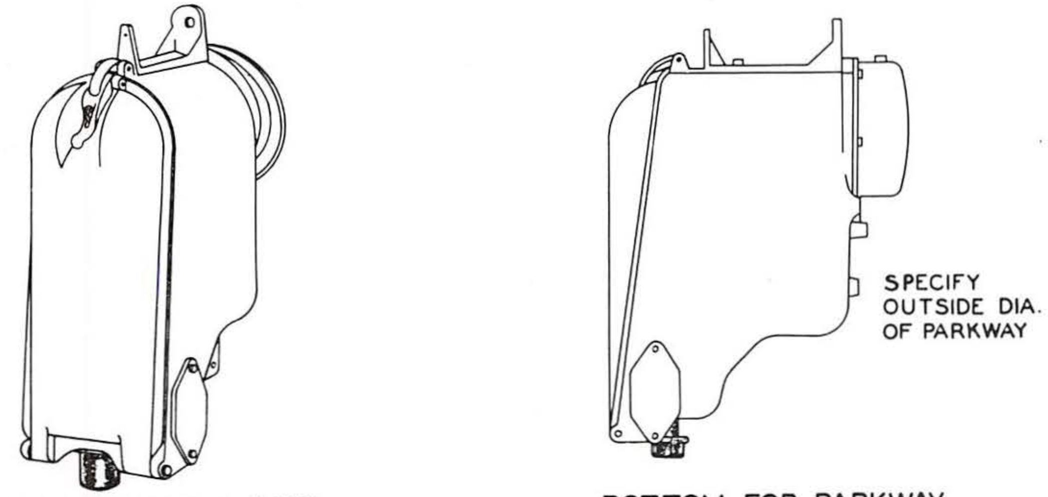
(d) Lock stud in position with nut 1.

NOTE: Adjustment may be sealed with car seal as above.


SPECIFY
OUTSIDE DIA.
OF PARKWAY

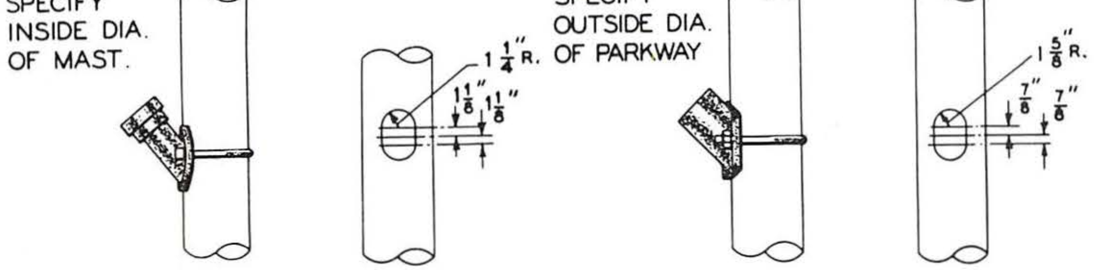
SIDE FOR 2-INCH CONDUIT

SIDE FOR PARKWAY


SPECIFY
OUTSIDE DIA.
OF PARKWAY

BOTTOM FOR 2-INCH CONDUIT

BOTTOM FOR PARKWAY


SPECIFY
INSIDE DIA.
OF MAST.
$1\frac{1}{4}''$ R.
$1\frac{1}{8}''$
$1\frac{1}{8}''$
SPECIFY
OUTSIDE DIA.
OF PARKWAY
$1\frac{5}{8}''$ R.
$\frac{7}{8}''$
$\frac{7}{8}''$

FOR 2-INCH CONDUIT

DRILLING

FOR PARKWAY

DRILLING

Figure 32. Signal and mast couplings.

H. Wire Conduits and Couplings

After the signal housing has been mounted, the next step is to run the operating wires. There will be one or two pairs of wires for operating the HG and DG relays (depending on whether the control circuits are polar or neutral), a pair of wires for the lamp circuit, and several additional wires for circuits through the contacts of the relays.

A 2-inch flexible conduit is standard on SC operative heads. The fixed signal is furnished with a 3/4-inch flexible conduit.

Various couplings are shown in Figure 32, both for the signal and the mast, for wire or cable.

The wires should be fanned out and laid flat upon the bottom of the housing, their loose ends lying along the bottom edge in a row and hanging out of the door.

J. Connecting the Wires

The terminal board for the standard polar-neutral SC mechanism with 4FB contacts on the HG relay and 4FB contacts on the DG relay is shown in Figure 15. Figure 17 shows terminal board for the polar-neutral SC mechanism with 6FB contacts on the HG relay and 4FB contacts on the DG relay. Figure 19 shows the terminal board for the neutral-neutral SC mechanism with 4FB contacts on the HG relay and 2FB contacts on the DG relay.

The incoming wires, after being identified, should be passed behind the terminal board and threaded through the holes adjacent to the terminals to which they are to be connected. The wires should then be cut to the proper length and eyelets applied. The terminals are insulated and can be unscrewed by a standard G-R-S 1/2-inch hex. socket wrench.

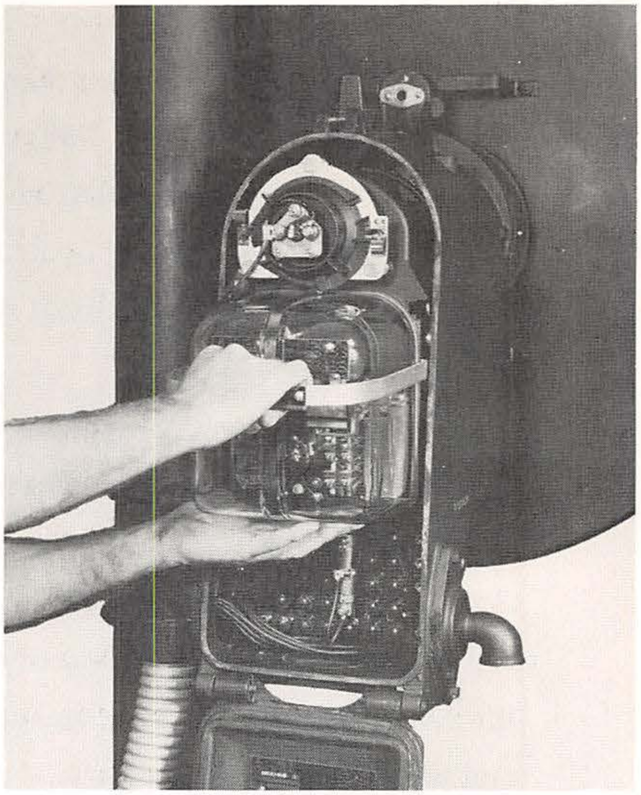


Figure 33.
Inserting the mechanism in the signal housing.

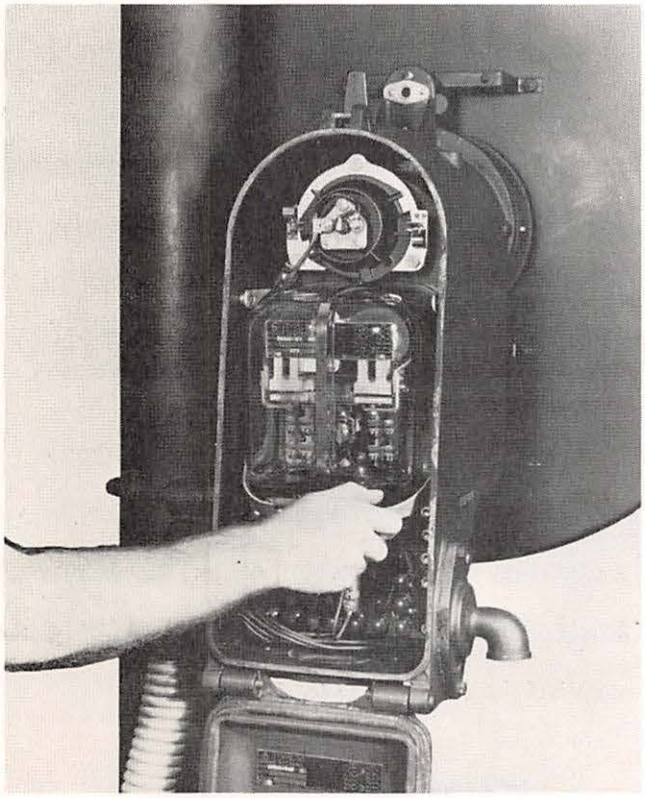


Figure 34.
After mechanism has been thrust forward to engage plugboards, press handle down as shown to lock mechanism in housing.

K. Inserting the Mechanism

The mechanism is carefully packed in a carton and shipped separately from the signal housing. It should be stored in a dry place until ready for use.

Mechanisms should be transported to the site of the installation in their cartons and the same care should be used in unpacking and handling as would be used in the handling of any other relays.

After the mechanism has been removed from its carton, examine it for any breakage that may have occurred in shipment, clean the lens or cover glass, and blow off any dust or particles of shipping materials that may have accumulated. See that the plugboard holes are clear. Check the housing also for dust and foreign substances.

Before plugging the mechanism into the housing, make sure that the circuit number on the mechanism name plate agrees with the circuit number on the housing name plate as shown in Figure 20.

The most convenient way to insert the mechanism is to grip the handle in one hand, placing the other under the mechanism's glass case. Raise it on to the tracks on either side of the housing, Figure 33, and slide it forward until both plugboards engage. The sliding movement should be accompanied by force sufficient to insure that the plugboard surfaces meet. Lower the handle as far as it will go, as shown in Figure 34. This action applies the additional pressure exerted by the leaf springs on either side of the housing, and squeezes the plugboards into close contact.

When removing a mechanism, raise the handle to the horizontal position and pull it towards you. Ease the plugboards apart by a steady pull on the handle accompanied by a sidewise rocking motion. As the mechanism slides out, support it, as before, with one hand under the glass case.

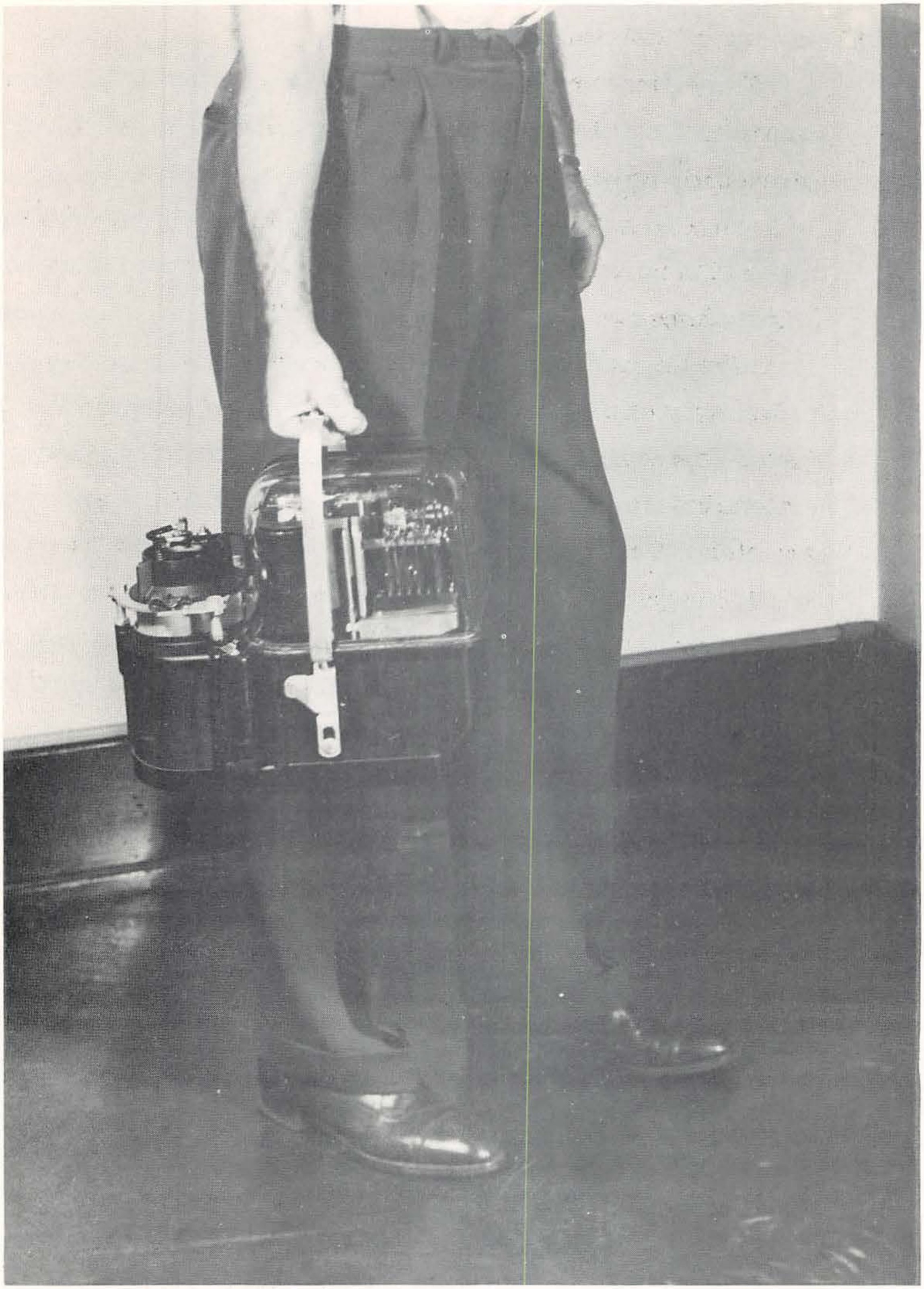


Figure 35. The mechanism can be carried by the handle.

The mechanism can be carried by the handle, Figure 35. When setting a mechanism down, place it on the plugboard surface, first making sure that there are no rough raised surfaces which might scratch the lens or cover glass.

L. Inserting or Replacing the Lamp

To insert the lamp in the signal, turn reflector unit clockwise until it unlatches and then withdraw it. If it is raining or snowing, protect reflector surface if hot, as sudden cooling may crack it. Be sure that lamp is properly seated in its socket before replacing reflector unit; then turn it counterclockwise to lock in place.

M. Cleaning Reflector and Lenses

The reflector, lenses, and cover glasses should be cleaned periodically with a chamois skin or a soft, lint-free cloth. To avoid scratching the lens, gritty substances must not be allowed to accumulate in the chamois skin or cloth. Alcohol or lacquer thinner will help in removing incrustations from the outer lens.

N. Checking Lamp Voltage

After making sure that the wires to the signal have been properly connected, the light energy should be applied. The candlepower of the lamp is greatly affected by voltage changes. The lamp voltage should be checked at the time of installation and at any time thereafter when alterations have been made in the power supply that cause a change in voltage at the signal. Excessive voltage greatly reduces the burning life of the lamp. Under-voltage materially reduces the candlepower, and, consequently, the range of the signal.

Connect the voltmeter across the lamp terminals on the reflector unit and adjust the voltage by varying the lamp resistor on the terminal board below the mechanism.

In general, it is recommended that lamps be burned at 10 per cent under rated voltage to increase the average life. For low-wattage lamps, it will be found necessary to burn them at or close to the rated voltage in order to obtain adequate daylight range. It is also recommended that nothing lower than a 10-watt lamp should be used in a stepped-lens signal.

P. Checking Operating Voltage

The operating voltage or current, whichever is being measured, should be enough above the specified working values to insure a margin in case of voltage drop which may occur if batteries are drained during a power outage. Current should not exceed 50 per cent of the rated values, as it is wasteful and does not provide any better operation of the mechanism.

Q. Sighting the Signal

On all signals, except dwarfs, a sighting device is provided on top of the housing. This device has been adjusted in the factory and should not be removed or readjusted in the field. By sighting through the hair-line peep sight and by manipulating the separate horizontal and vertical adjustments, the light beam is aligned with the track.

For signals mounted on the side of masts, proceed as follows:

1. Before sighting a resiliently mounted signal, the resilient mounting bracket should be adjusted as explained on page 37.
2. With a fine wire clean the peep-hole in the rear of the sighting device. It sometimes gets clogged with paint and dirt.
3. Loosen the signal slightly on its vertical stud, Figure 28. This will permit it to be turned in a horizontal plane. By looking through the sight you can set the signal so that the vertical cross-line in the sight bisects the point at which it is desired to project the most intense part of the main beam.

4. Lock the horizontal adjustment by means of the set screw in the mounting bracket, Figure 28.
5. Draw up tight the two nuts on the vertical stud.
6. Tip the signal housing up or down by turning the nuts on the adjusting stud under the front end of the signal until the horizontal crossline in the sight bisects the desired point.
7. Lock the vertical adjustment by tightening both nuts.

When the signal is mounted on top of the mast, Figure 29, the four nuts (two not shown) should be loosened for adjusting horizontally. Tighten the adjusting nut on the side towards which it is desired to rotate the signal. When the vertical crossline in the peep-sight bisects the point desired, the signal is clamped in place by drawing up the nut on the opposite side, after which both adjusting nuts should be locked by tightening up their jam nuts. For vertical adjusting proceed as for bracket-mounted signals.

The bases of bridge signals which are mounted on the girders, Figure 24, have slotted holes, Figure 23, for horizontal adjustment. The same type of base is provided for dwarf signals, Figures 25 and 26, which, however, are not adjusted by peep-sight. When the two-arm dwarf signal is aligned with the track, the lower arm is adjusted first and locked before the upper is aligned.

R. Adjusting the Close-Up Beam

Signals are equipped with small 40-degree deflecting roundels to provide a close-up aspect for the engineman who stops under a signal. The roundel can be turned in its support to throw the beam across the track. To reach roundel, remove hand-hole cover, Figure 36.

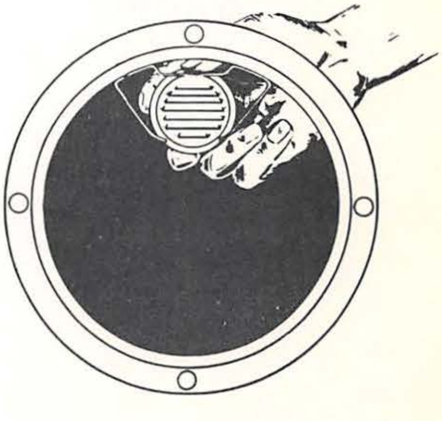


Figure 36. Adjusting roundel.

S. Replacing a Broken Lens or Roundel

1. Make sure that the replacement lens or roundel is of the same design as the original. This is particularly important as concerns the lens. The Type SC signal stepped lens has a 5-inch focal length, the designation for which is molded in the rim of the lens, for example: 8-3/8D x 5F etc. Make certain that the term "5F" appears in the designation.
2. Before installing the new lens or roundel, apply a sealing compound (such as Vulcatex) on the surface of the bezel ring to prevent water from entering.
3. Tighten screws evenly around the bezel ring to avoid the possibility of cracking the glass.

T. Changing Signal from Straight Track to Curved Track Application

As shown in Figures 11 and 13, various outer roundels are available to cover the many topographical conditions encountered in railroad practice. When changing a Type SC signal from a straight to a curved track application, the proper deflecting roundel should be selected in accordance with directions given in Pamphlet 530, "How to Select the Proper Optical Combination for Any Given Condition." In addition to the roundel with its gasket, the following will be required:

Quantity	Description	Drawing Reference
1	Adapter Ring	43983-46
4	Screws (for compound lens)	33287-8
4	Screws (for stepped lens)	33287-13

When these materials have been secured, proceed as follows (Figure 25 shows a signal with these parts installed):

1. Remove outer rim on which sheet-metal hood is mounted. Be careful that lens does not fall out of its bezel ring.
2. Assemble adapter ring 43983-46 after first applying sealing compound to machined surfaces.
3. Assemble roundel in position to direct the deflected or spread beam in the required direction. An arrow molded in the glass of the deflecting roundel indicates the direction in which it deflects the beam. A spredlite roundel has the word "TOP" molded in the glass.
4. Place outer ring over roundel and fasten with the 4 larger screws, tightening the screws evenly around the ring.

U. A Final Check

Check these before placing signals in service:

1. Be sure that the operating voltages and polarities are right.
2. Be sure that the reflector and lenses are clean.
3. Be sure that the lamp is clean and properly seated in its socket.
4. Be sure that resilient mounting is properly adjusted.
5. Be sure that signal is properly aligned. Check both horizontal and vertical adjustments.
6. Be sure that all adjustments are properly tightened to avoid subsequent movement of the signal.
7. Be sure that the proper lens combination is used for the particular track conditions at the location.
8. Be sure that the mechanism is properly locked in the housing and that the reflector unit is in place and locked.

V. Don't's

1. Don't change the reflector or socket adjustment. This has been factory adjusted and should never be touched. If the aspect is not satisfactory, the trouble may be caused by:
    (a) Low voltage at lamp terminals.
    (b) Signal improperly aligned with respect to the track.
    (c) Wrong lens combination for the location.
2. Don't open the signal mechanism on the right-of-way. Seals on the mechanism should not be broken, nor the mechanism opened, except where adequate facilities are available for repairs.
3. Don't oil the signal mechanism at any time. It is equipped with bearings which require no lubrication whatever.
4. Don't check voltage at the source of supply - there is always a line drop in potential which makes such a check useless. Measure voltage at the lamp terminals and operating currents through the relay coils.
5. Don't burn the lamp at a lower voltage than that recommended.
6. Don't burn the lamp at excessive voltage; as a general rule never exceed recommended voltage by more than one-half volt.
7. Don't force excessive current through the relay coil.
8. Don't expect a lens projecting a concentrated beam to cover a curved track.
9. Don't expect a beam with wide spread to have the same range as a concentrated beam.
10. Don't remove or readjust the sighting device. This has been factory adjusted and should not be changed.

IV. ORDERING REFERENCES FOR REPLACEMENT PARTS

A. Lamps

Order new lamps by sending us the catalog ordering reference and drawing number of the lamp as listed in G-R-S Catalog, Section H, Part 39.

B. Adjustable Lamp Resistance

Order by giving the drawing number stamped on mechanism name plate.

C. Reflector Unit

If the reflector is broken, send us reflector unit, and we will replace the reflector and refocus it. Give us the drawing number on the mechanism name plate and the drawing number of the lamp.

D. Lenses and Roundels

Should you wish to replace a broken lens or roundel, give us the drawing number stamped on the housing or mechanism name plate for which it is intended.

E. Coils

Order coils by giving the drawing number stamped on mechanism name plate. State on which relay the coil is to be assembled, the HG or DG relay.

F. Rectifier

To order a rectifier for polar mechanisms, give the drawing number stamped on name plate of the mechanism for which it is intended.

G. Contacts

Order contacts by giving the drawing number stamped on mechanism name plate and state on which relay the contacts are to be used. Since contacts are molded in blocks and there are three spaces under each relay armature for a maximum of three contact blocks, it will be necessary to state in which space the block of contacts is to be used. These spaces may be numbered 1, 2, 3, 4, 5 and 6 for convenience, from left to right across the mechanism, looking at it from the side from which the contacts can be seen. Spaces 1, 2 and 3, therefore, are directly under DG relay. Spaces 4, 5 and 6 are under HG relay.

H. Arrester

The shunt gap lightning arrester on the terminal board in the housing should be ordered as follows:

"one-shunt gap lightning arrester for Type SC Signal - drawing reference 59134 Gr. 1".

J. Glass Case

Should glass case protecting working parts of the mechanism be broken, order a new one as follows:

"one-glass case or Type SC Signal - drawing reference 37380-27".

K. Other Parts

In the absence of a catalog, and until one is issued on the Type SC Signal, it is recommended that the drawing number stamped on the name plate of the mechanism or housing or both be given whenever parts are ordered. Name the part as clearly as possible or call on our nearest district office for assistance in ordering.

* * *

Popular Welded Steel Cases

Wayside instrument cases have undergone many changes in design in recent years, so much so that what is being purchased today does not resemble what was available even ten years ago.

Wood has given way to cast iron, and cast iron to sheet steel. Cases today are made more roomy to handle the larger amounts of signal apparatus required at signal locations. They are also being designed with an eye to convenience. Wiring is now made more accessible by back hinged doors. More thought has been given to proper ventilation, to gasketing, and to cable lead-in. Cases today are lighter to handle, but sturdy enough to meet the usual signaling requirements.

On the following pages drawings are reproduced with brief notes showing the types, dimensions, and drawing numbers of the cases in popular demand today. There has been no attempt to show all the possible interior arrangements, nor the various insulating linings.

Specifications call for cases to be made of copper-bearing rust-resisting sheet steel. During the war this material became scarce, but is again released. Insulation is Celotex, 1/2-inch thick. Terminal boards are made of wood usually, and can be supplied in "Ebony Asbestos". Shelving is made of pine. Cable outlets are on the sides or bottoms of the cases. Flaps can be provided over padlocks to shield them from the weather. Ventilators on doors are optional. Anchor bolts, padlocks, shelving, etc. are furnished as specified by the purchaser.

* * *

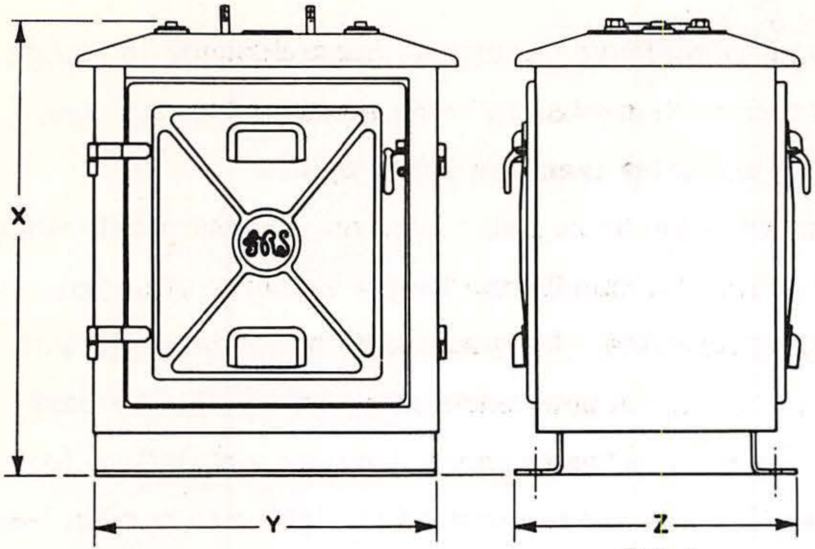


FIG. A

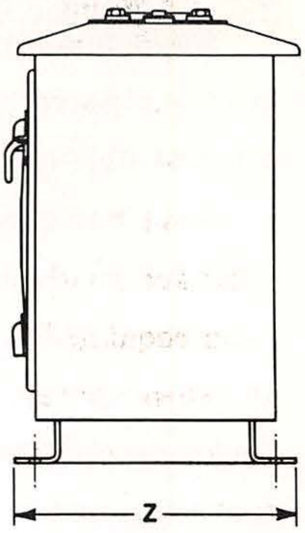


FIG. B

		X	Y	Z	Dwg. No.
A	Single swing door (front and rear). Case can support a pole	5' 7-1/8"	2'4"	24"	36006-14
		3' 8-1/8"	2'10"	24"	36006-15
B	Same as A, but with swing door on front only.	3' 8-1/8"	2'10"	24"	36006-16
		5' 7-1/8"	3'2"	24"	36006-20

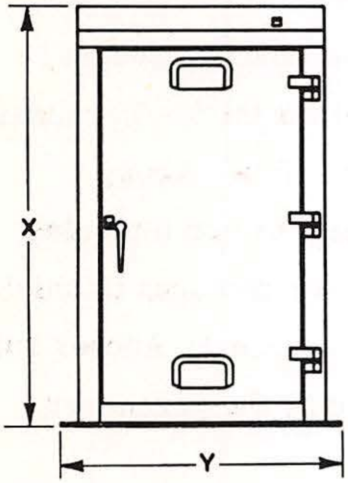


FIG. C

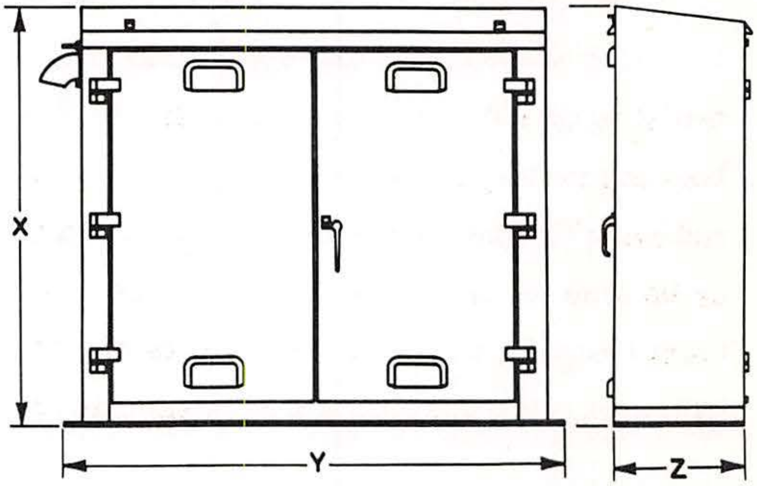


FIG. D

		X	Y	Z	Dwg. No.
C	Single swing door (front and rear). For mounting on concrete base.	4' 5-7/8"	2'7-1/2"	23"	56101-103
D	Same as C, but with two swing doors (front and rear).	4' 5-7/8"	4'11"	23"	56101-104

Birthdays of the Month

The following men who are prominent in the railway signaling and communications field, celebrate their birthdays this month:

H. A. Appleby, signal engineer, Western Lines, A T & S F, was born February 13, 1897.

G. H. Dryden, signal engineer, B & O, was born February 15, 1870.

R. B. Elsworth, signal engineer, Buffalo and East, N Y C, was born February 14, 1880.

W. N. Hartman, superintendent telegraph and signals, C & O, was born February 1, 1891.

R. A. Hendrie, assistant superintendent telegraph and telephone, M P, was born February 4, 1890.

A. P. Hix, signal engineer, Terminal Railroad Association of St. Louis, was born February 5, 1882.

T. C. Seifert, assistant signal engineer, C B & Q, was born February 13, 1879.

* * *

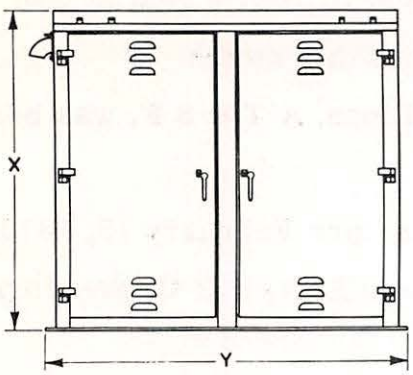


FIG. E

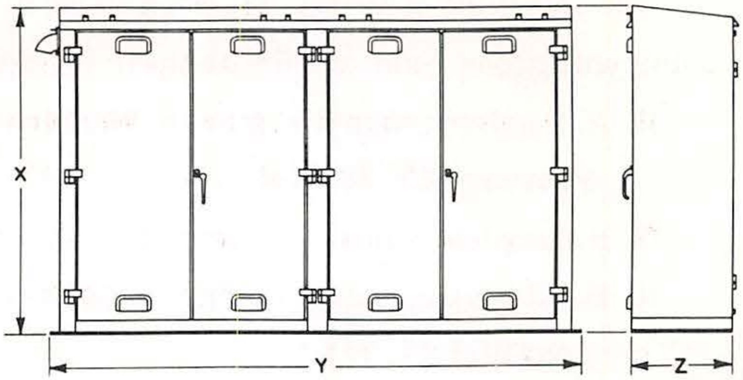


FIG. F

		X	Y	Z	Dwg. No.
E	Two swing doors (front and rear). Front doors are locked independently.	6' 3-3/8''	6' 9''	23''	56101-108
F	Same as C, but with four swing doors (front and rear).	6' 3-3/8''	9' 8''	23''	56101-106

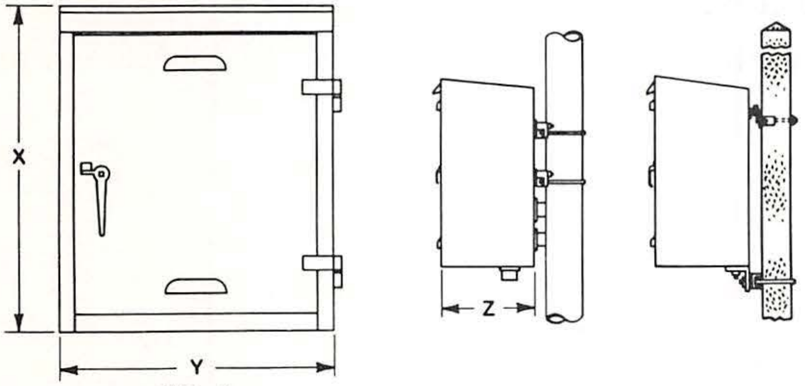


FIG. G

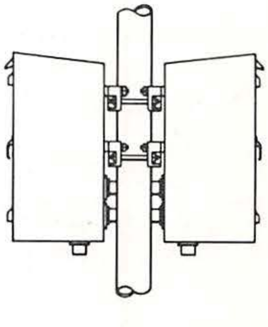


FIG. H

		X	Y	Z	Dwg. No.
G	Single swing door. For pipe post or concrete post mounting.	3' 10-1/2'' 2' 8-1/2''	2' 3'' 2' 3''	16'' 16''	54311-50 54311-52
H	Same as G but with fittings for mounting two cases back to back on pipe post.	3' 10-1/2''	2' 3''	16''	54311-68

Roy Morris Joins St. Louis

Roy L. Morris, formerly general signal inspector of the Missouri Pacific System, has become associated with the St. Louis Office of the General Railway Signal Company as a sales engineer. Mr. Morris was born on June 8, 1896 at Webb City, Missouri, and received his education in that state.

On October 16, 1916 he entered railroad service as a signal helper for the Missouri Pacific Railroad, becoming assistant signalman in January, 1917, and signalman in the latter part of the same year. After military service in World War I, Mr. Morris returned to the Missouri Pacific in 1919, and was promoted to construction foreman in January, 1920. In February, 1925, he assumed the position of signal foreman on the Eastern Division of the Missouri Pacific between Jefferson City and St. Louis, following which, in February, 1938, he became signal supervisor of the St. Louis Terminal and Illinois Division. On October 1, 1939, Mr. Morris was appointed general signal inspector of the Missouri Pacific System, the position he held at the time of his association with the General Railway Signal Company.

* * *

Rod Gould Dies

It was with deep regret that we heard of the death of Rod Gould, who has been associated with our Chicago office since 1923.

Born on May 25, 1893, Roderick Alfred Gould, affectionately known as "Rod", received his education in the public schools of his birthplace, Chicago. After high school he took a business course in Chicago Business College.

In 1910 Rod started as stenographer with the Union Switch and Signal Company, in Chicago, leaving them in 1911 to go with the Federal Signal Company, as stenographer and chief clerk.

In 1923 Rod joined our Chicago office as chief clerk and remained in that capacity until his death.

Rod had a capacity for making friends easily with his quiet, friendly manner. A hard and thorough worker, he shouldered office detail with apparent ease, and contributed much to the efficient running of Chicago office. With ever a kind word and cheerful smile for everybody, Rod will be missed by all his associates and friends of G-R-S.

* * *

GENERAL RAILWAY SIGNAL COMPANY

G-R-S NEWS
January 1947

Phantoms, Beam Dilution and Some Remedies

For a number of years in cooperation with U.S. railroads we have been making tests to determine what conditions cause phantoms and dilute the colored light beam from a color-light signal. The following is a brief report of the study together with some practical remedies which were found to be effective.

* * *

I. PHANTOM INDICATION

A. Searchlight Signals

The display of a phantom indication by a Type SA or SC searchlight signal does not cause any difficulty because G-R-S searchlight signals are so constructed that any phantom indication is a true indication of the position of the signal mechanism.

B. Doublet Lens Units

Signals equipped with doublet lens units, Figure 1, such as Types D, E, G, L, FA, MD, ME, and F signals, do not have this advantage.

There are two causes for phantom indication from a doublet lens unit. The chief cause is that light from an external source may strike the external surface of the lamp bulb and be reflected back through the lenses. A somewhat lesser cause is that external light may also be reflected from the surface of the lamp filament, especially if the filament is a new and shiny one. In either case, such external light will pass through the colored inner lens and will assume the color of that lens, thus producing a phantom indication.

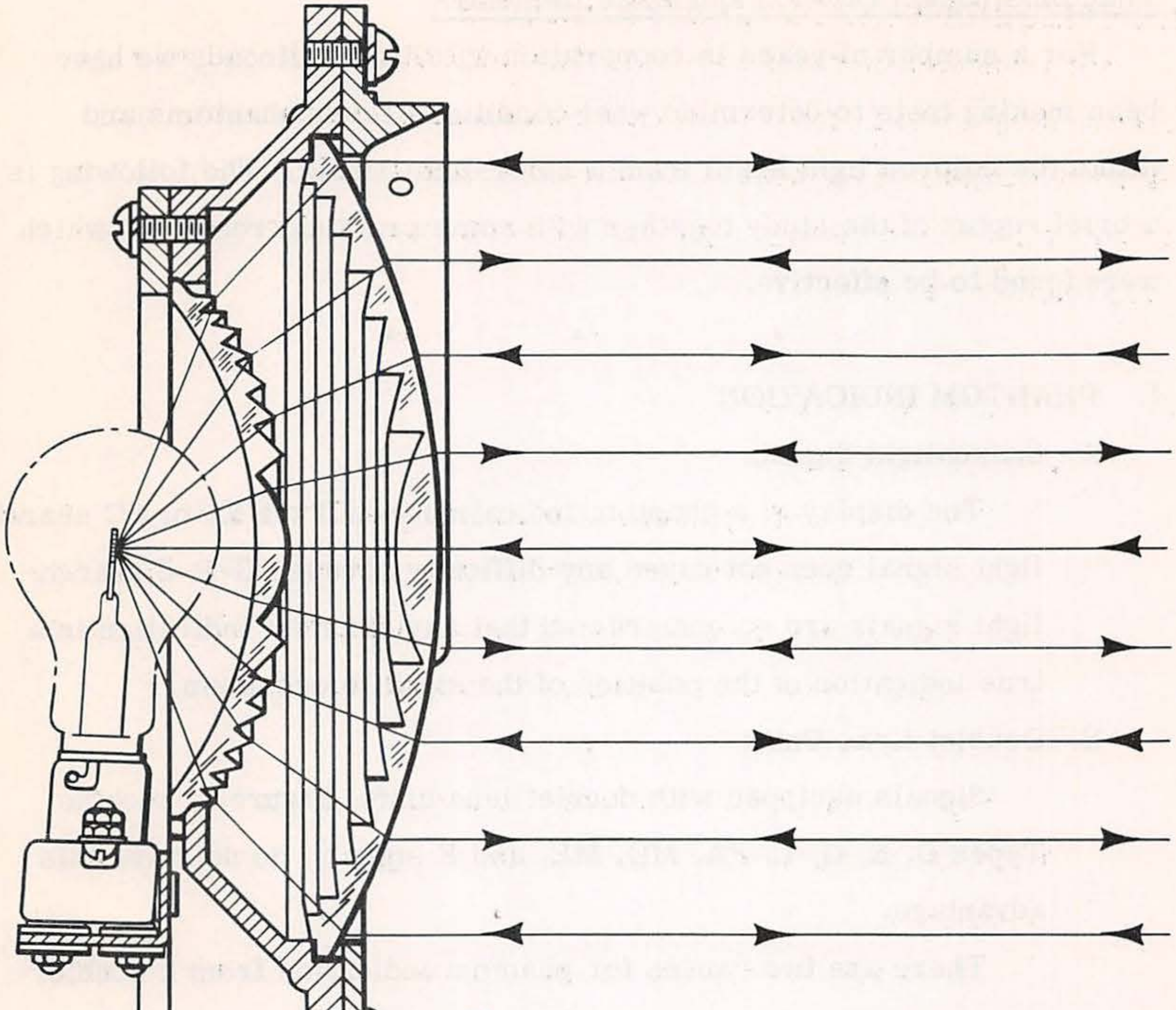


Figure 1. Doublet lens unit showing how light from an external source striking surfaces of the lamp bulb and lamp filament tends to be reflected back upon itself and causes the signal to appear as though it were lighted. (This diagram illustrates the general course of the light rays. It is not intended to indicate the exact amount of refraction caused by the lenses at particular points.)

The intensity of the phantom indication can be substantially reduced by the use of either a G-R-S Anti-Phan disc, or a Phankill unit (a U.S. & S. development).

An Anti-Phan disc is simply a circular piece of wire cloth, woven of very fine brass wire so that there are many tiny openings per square inch. The brass is given a dull black oxidized finish. The disc is placed over the outer surface of the inner lens. It is made large enough so that the wire cloth may be wrapped around the edges of the lens. The lens and attached Anti-Phan disc are then fastened in place with the regular lens bezel ring.

When light from an external source is reflected from the signal the light must pass through the meshes of the Anti-Phan twice, once going in and once going out. The fine black meshes tend to diffuse and weaken the reflected light.

The Phankill unit, Figure 2, is a circular metal disc shaped like a diverging concavo-convex lens. It has many small triangular passages through which light from the signal may pass quite easily, but external light must be within about 8 degrees of the axis of the signal beam to get through the tubelike triangular holes. The Phankill unit is mounted in a special ring in front of the outer lens. It requires a cover glass to protect it.

The performance characteristics of these two devices are follows:

Type of anti-phantom device	Percent of beam candlepower transmitted	Percent of phantom reflected
None	100	100
Anti-Phan	65	50
Phankill	70	40

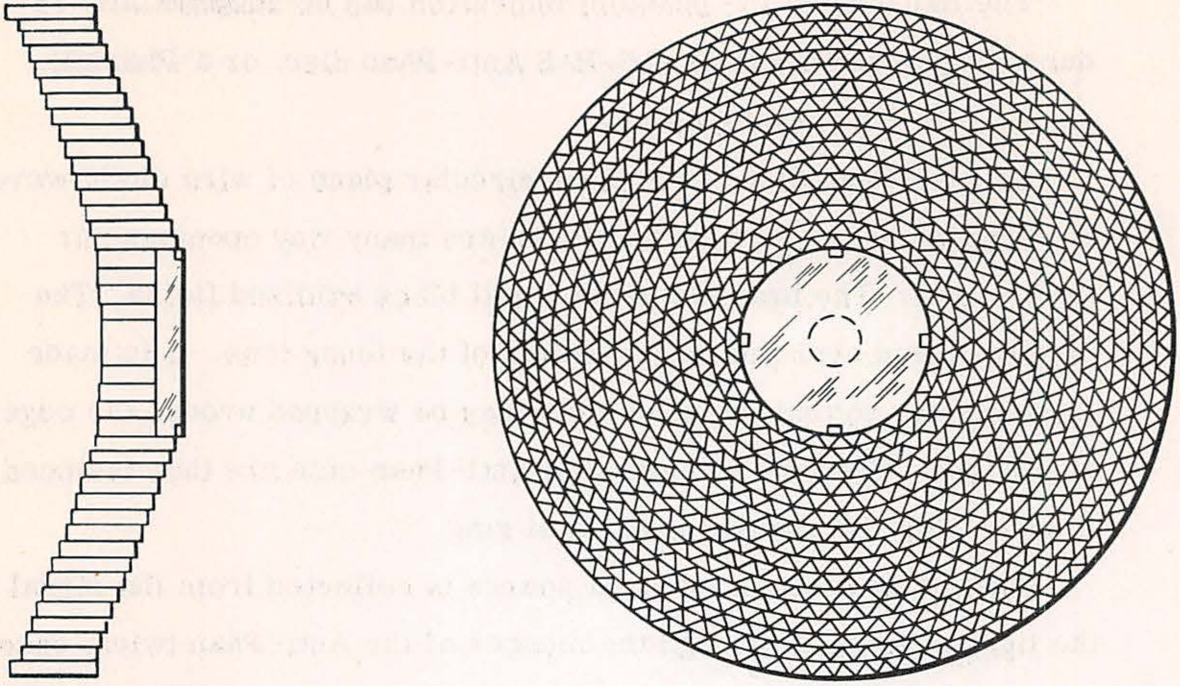


Figure 2. Front and cross sectional side view of a Phankill unit. The circular opening in the center of the unit is fitted with a deflecting roundel for close-up indications when used on high signals. On dwarf signals, the center opening is closed with a black felt disc.

Other factors to be considered when comparing the Anti-Phan disc with the Phankill unit are:

A. Anti-Phan
  1. Comparatively low in cost.
  2. Requires no extra parts for installation. Anti-Phan disc is placed over outside of inner lens. Lens bezel ring holds both lens and Anti-Phan in place.
  3. Uniformly reduces all reflected light within the angle of the beam which the particular signal projects.
  4. Available to fit all G-R-S signals.

B. Phankill

1. Higher cost than Anti-Phan.
2. Requires special ring to attach Phankill unit to signal outside of outer lens.
3. Requires a cover glass for protection.
4. Requires extra long screws.
5. Eliminates all reflected light beyond about 8 degrees around the axis of the beam.
6. Not at present available for 8 3/8-inch doublet lens unit (Types D, E, G, and L signals) but could be made to fit. Is available for 6 3/8-inch doublet lens units (Types FA, MD, and ME signals).
7. Not at present available for 5-inch doublet lens units (Type F signal), but a small Phankill size is available which could be applied.

II. DILUTION OF COLOR OF LIGHT BEAM

The dilution of the color of the light beam from a color-light signal is caused by light from an external source reflecting from surfaces of the unit in such a manner that the reflected external, and relatively colorless, light mixes in with the normal colored light beam from the signal and causes an apparent dilution of the color of the beam. Under extremely unfavorable conditions, red, for example, may be mistaken for yellow. This phenomenon is more likely to occur in the sunnier and flatter parts of the country when the sun is relatively low on the horizon.

Consider the conditions affecting an engineman on C.T.C. territory on a long tangent passing siding parallel to a tangent main line. He is faced with two signals, a high signal for the main line and a dwarf for the passing siding. The high signal is equipped with a compound lens and does not have an outer roundel, but has a small inner deflecting roundel for close-up indications installed at the top of the lens barrel. The dwarf signal has a compound lens, the same as the high signal, but its inner deflecting roundel is installed at the bottom of the lens barrel for close-up indications. The dwarf is also fitted with an outer deflecting roundel with the prisms set horizontally to produce an upward deflection.

Both signals are displaying a red aspect, but each is displaying its aspect under very different conditions. Because the signals are set at different heights, their lenses are at different angles to the source of the external light (the sun, in this case). The lenses are also at different angles to the engineman's line of vision.

The outer deflecting roundel on the dwarf signal deflects a certain amount of the transmitted light upward, thus subtracting that much light from the distant part of the beam and causing it to be just that much weaker than the beam from the high signal. Furthermore, the prisms of the outer deflecting roundel of the dwarf signal are set horizontally. This increases the tendency of the dwarf signal to reflect external light. In addition, the small inner deflecting roundel for close-up, being at the bottom, is seldom shielded by the hood. Thus the transmitted light from the dwarf signal is less than that from the high signal, and the reflected light from the dwarf signal is more than that from the high signal.

The result is that the engineman sees one signal displaying a definitely red aspect and the other signal seemingly displaying some other color not like the first.

In its judgment of color, the human eye relies strongly on comparison. A pure red aspect looks even more red when directly compared to a diluted red. A light or diluted red may look red when seen alone.

Place it right next to a much stronger red, and it looks pink, orange, or even yellow, especially when both colors are viewed from a considerable distance.

The problem, then resolves itself into one of keeping as much reflected light as possible out of the normal beam of the signal.

A. Doublet Lens Units

Considering the doublet lens unit first, there are two ways by which reflected external light enters the beam to dilute it: by reflection from the outer surface of the outer lens or by reflection from the outer surface of the inner lens.

The outer surface of the outer lens of a doublet signal is convex and, being molded, contains many minute irregularities. Both these factors tend to diffuse any reflected light and prevent it from diluting the normal beam to any great extent.

The outer surface of the inner lens presents a very irregular reflecting surface because of its stepped construction. It is a negligible factor in causing beam dilution.

In general, beam dilution is not an important factor in doublet lens signal, particularly as compared to the phantom indication problem, which can be partially overcome, as already mentioned, by the use of the Anti-Phan disc. It has not been felt necessary to develop a device to minimize beam dilution in doublet lens signals.

B. Searchlight Signals, Compound Lens

The causes of beam dilution in searchlight signals vary with the lens system employed (stepped or compound) and with the height of the signal (dwarf or high).

Dilution of the beam of a high signal equipped with a compound lens is principally caused by external light being reflected from

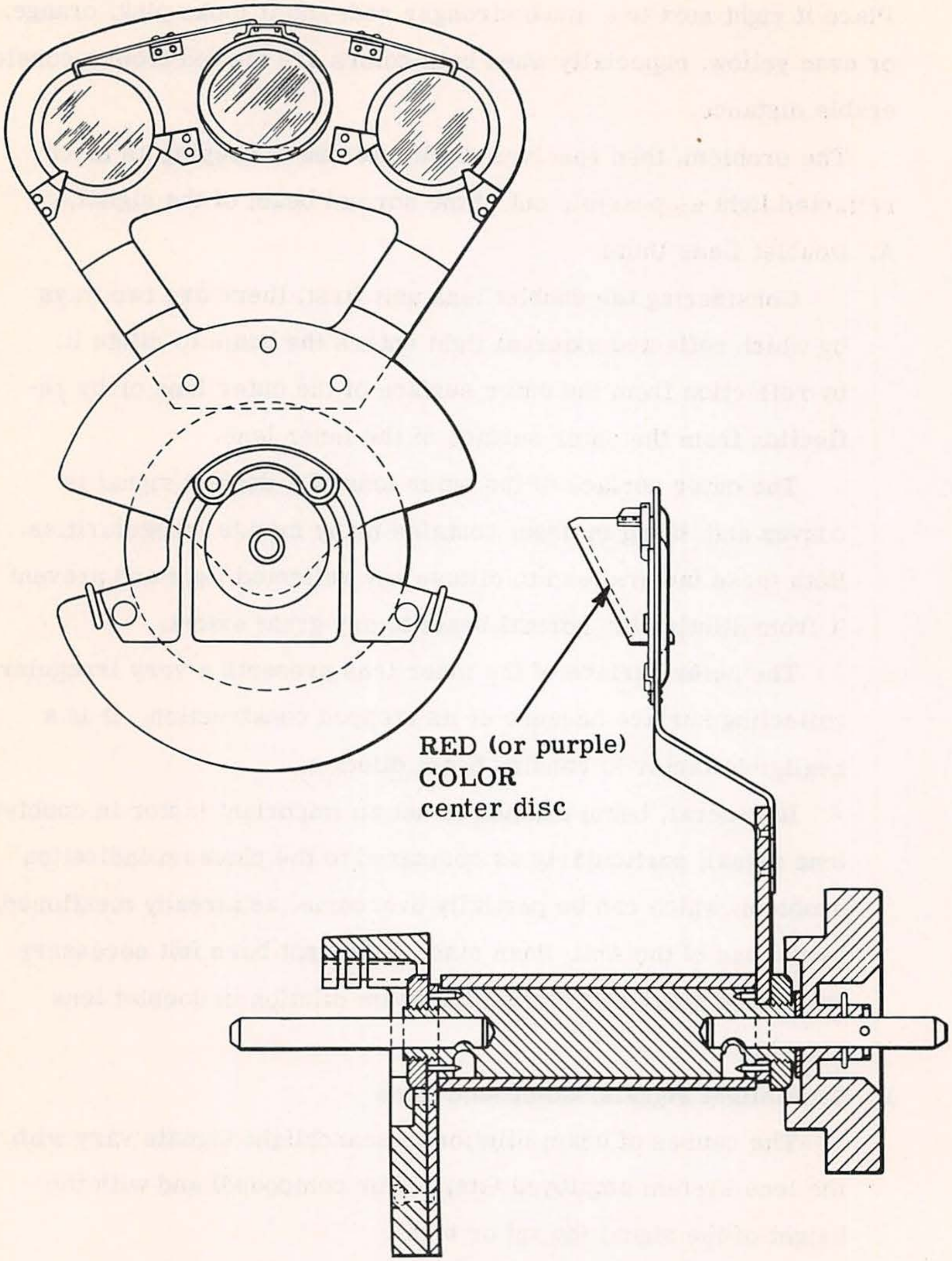

RED (or purple)
COLOR
center disc

Figure 3. All Type SA signals after Serial No. 30,000 have red color discs slanted as shown here to deflect external light out of the signal beam.

four surfaces: the external convex surface and the internal plane surface of the outer plano-convex lens, and the external convex surface and the internal plane surface of the inner plano-convex lens. In addition, there is also reflection from the outer roundel, if such is used, and there is reflection from the outer surface of the color disc in signals where the color discs are set vertically. All Type SC signals have slanted color discs to avoid this. All Type SA signals after Serial No. 30,000 have the red color disc mounted on a slant as shown in Figure 3 (color dilution of yellow or green is, while undesirable, not unsafe).

Slanting the color disc deflects the external light upward to the serrated black cone in both SC and SA signals, where it is dissipated. The effect of slanting the color disc is explained and illustrated on pages 13 and 14 of the February 1946 issue of the G-R-S NEWS in connection with a description of the Type SC signal.

U.S. & S. searchlight signals are equipped with a cone-shaped red color disc. Tests on G-R-S searchlight signals indicate that slanting the red color disc is a better means of diverting external light out of the signal beam - at least as far as G-R-S searchlight signals are concerned.

The most effective method developed so far to decrease the dilution of the light beam from a compound-lens high signal is the use of a Phankill unit and an inclined flat cover glass, as shown in Figure 4. The Phankill unit reduces the amount of light that can enter the signal near the axis of the beam, and eliminates all incoming light at an angle greater than 8 degrees from the axis of the beam. The inclined flat cover glass may also be a spredlite or deflecting roundel as circumstances require. A

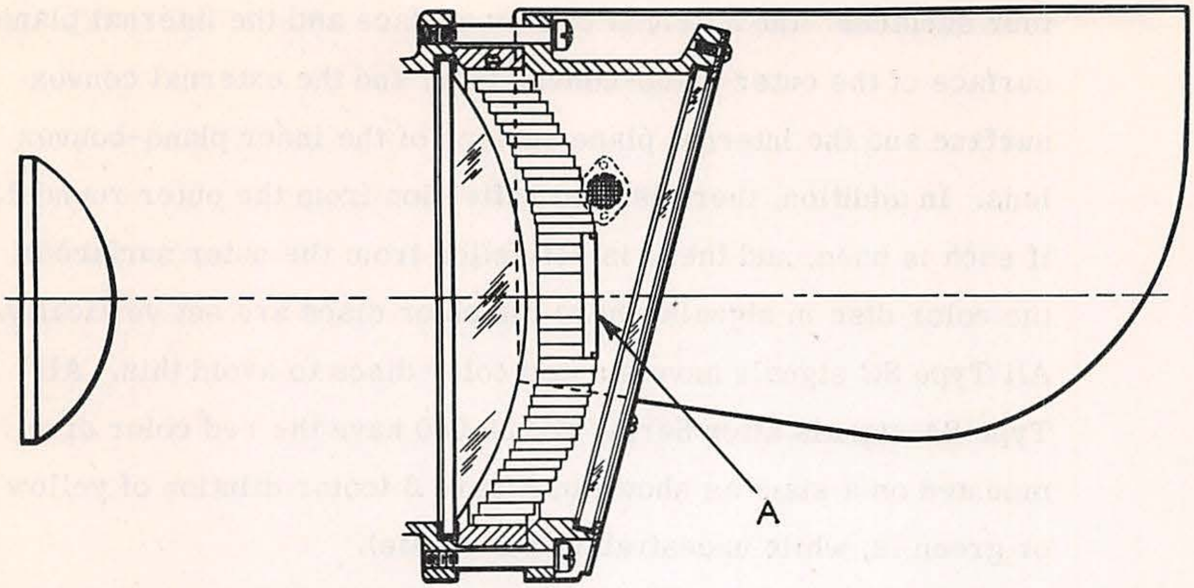


Figure 4. Sectional side view of Type SA signal equipped with Phankill unit and inclined flat cover glass (or outer roundel). Reference "A" in center of Phankill unit is a close-up deflecting roundel when used on high signals and is a black felt disc when used on dwarf signals.

small deflecting roundel to provide a close-up indication is mounted in the center of the Phankill unit at "A" in Figure 4. This is necessary because the light normally deflected for this purpose by a small inner deflecting roundel at the top of the lens barrel would be blocked out by the Phankill unit.

Light rays from an external source, such as the sun or a headlight, are usually horizontal or above horizontal. The cover glass, as shown in Figure 4, is inclined so that reflections are directed at the ground instead of toward the engineman's eyes. It should be noted, however, that there are certain conditions which tend to defeat the purpose of this device. A signal thus equipped might be so located in relation to an adjacent body of water that the external light would strike the water at such an angle as to be reflected to the cover glass at the proper angle to be directed at the engineman's eyes and thus completely dilute the color of the signal beam.

Dwarf searchlight signals equipped with compound lens systems present the same reflection problems as high signals with compound lenses. In addition, the small inner deflecting close-up roundel, now on the bottom of the lens barrel, and the outer deflecting roundel, now placed so that its prisms are horizontal, together with the low position of the dwarf signal, substantially increase the possibility of reflection and attendant beam dilution.

The method at present recommended for reducing the dilution of the light beam from a compound-lens dwarf signal is the use of a Phankill unit and an inclined flat outer deflecting roundel mounted as shown in Figure 4. The prisms of the deflecting roundel are placed on the outside to reduce their effectiveness as reflectors, and the risers of the prisms, which are also potential reflectors, are painted a dull black. The close-up deflecting roundel is omitted from the center of the Phankill unit, and this space is closed off with a black felt disc. The close-up roundel is not used because as normally applied to a dwarf signal such a roundel tends to beam reflected light upward to the engineman, thus contributing to beam dilution. The upward deflecting effect of the inclined flat outer roundel is deemed sufficient for close-up indications. Blocking out the center of the Phankill unit with a felt disc obscures all surface reflections within 8 degrees of the axis of the signal beam, and the tubes in the Phankill obscure reflections at angles greater than 8 degrees.

C. Searchlight Signals, Stepped Lens

Dilution of the beam of a high signal equipped with a stepped lens is caused by external light being reflected from the outer surface of the stepped lens and from the outer surface of the roundel, if any. As in the case of the outer lens of a doublet lens unit, the lens of the stepped-lens searchlight signal is convex and, being molded, contains many minute irregularities. Both these factors tend to diffuse any reflected light and prevent it from diluting the normal beam to any great extent. The effects of reflection from the color discs are minimized in the same manner as for compound-lens searchlight signals.

There is a small amount of reflection from the plain glass that covers the serrated cone in the signal mechanism (this space is occupied by the inner lens in the compound-lens signal). In older models of the Type SA signal, this glass was set back near the focal point of the lens. This was an undesirable location, as light reflected from a point so near the focal point tended to fill the whole beam projected from the signal.

Beam dilution of stepped-lens searchlight high signals is not as great as for compound-lens searchlight signals. It may be remedied in the same manner as explained for compound-lens high signals, the addition of a Phankill unit and an inclined flat cover glass or outer roundel similar to the arrangement shown in Figure 4 for a compound-lens signal. A small deflecting roundel for close-up indication is mounted in the center of the Phankill unit at "A" in Figure 4. This is necessary because the light normally deflected for this purpose by the center of the stepped lens is blocked out by the Phankill unit.

Dwarf searchlight signals equipped with stepped lenses present the same reflection surfaces as high searchlight signals with stepped lenses except that dwarf signals are also equipped with outer deflecting roundels with horizontal prisms which substantially increase the possibility of beam dilution.

The problem is partially solved, the same as for the compound-lens dwarf, by the addition of a Phankill unit and an inclined flat deflecting roundel, Figure 4, with prisms toward the outside and the risers of the prisms painted dull black. The close-up deflecting roundel is eliminated from the center of the Phankill unit, and this space is closed off with a black felt disc.

It should be understood that the solutions given herein to the phantom and beam-dilution problems, while successful to an encouraging degree, are not necessarily ultimate developments in this matter. As further progress is made, we hope to inform you of it in G-R-S NEWS.

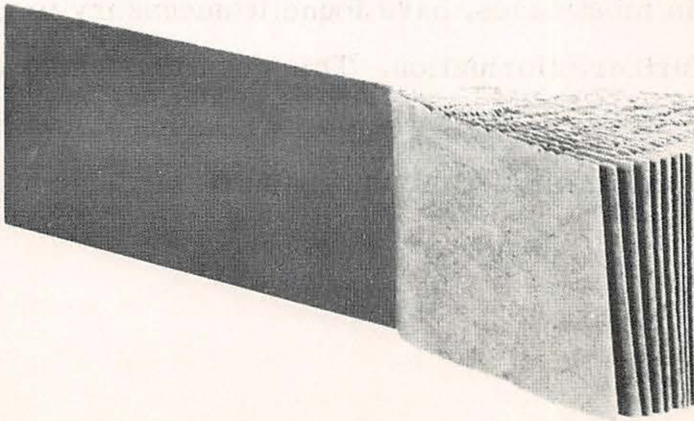
* * *

Lignolite Terminal Boards

Terminal boards for our control machines, relay racks, junction boxes, cases, and housings are now being fabricated from "phenolic lignolite", a board having a satiny black finish. This material has an interesting past.

For many years paper manufacturers extracted a brownish substance known as "lignin" from wood pulp. It was undesirable in paper so they dumped it in the river along with other waste products.

Lignin is a substance or a mixture of substances which, with cellulose, constitutes the essential part of woody tissue. It is a resin that bonds together the wood cells of a tree.



Lignolite board

Someone got the idea that if lignin held a tree together it certainly must be a remarkable binder. Experimentation by The Forest Products Laboratory, U.S. Department of Agriculture, began on the substance and so astonishing were the results that paper manufacturers began to salvage lignin from the waste products. They treated sheets of paper with it, stacked the sheets and subjected the pile to high pressures and temperatures. The result was a board, dark brown, mottled, with a smooth surface, tough and durable - to which was given the name "lignolite".

To provide a glossy or satiny black finish, the lignin-treated papers are sandwiched between two pieces of phenolic resin treated paper having the desired finish. The entire stack is pressed together. The resulting board, which is made in various thicknesses, goes by the name "phenolic lignolite".

It is this material which we now use for terminal boards. It has good insulating quality, drills easily, has high tensile (12,000 pounds per square inch) and flexural (20,000 p.s.i.) strength, and is economical.

* * *

Hinged Front Rod Drilling

On page 15 is a reproduction of questionnaire (Form 1201) which we are furnishing our district offices to supplement Folder F134 describing our hinged front rod.

We have received orders from a number of railroads for our hinged front rod, and, in most cases, have found it necessary to go back to our customers for further information. This question sheet was suggested by our St. Louis office, so that, when orders come in, we can furnish rods correctly drilled without the necessity of further correspondence.

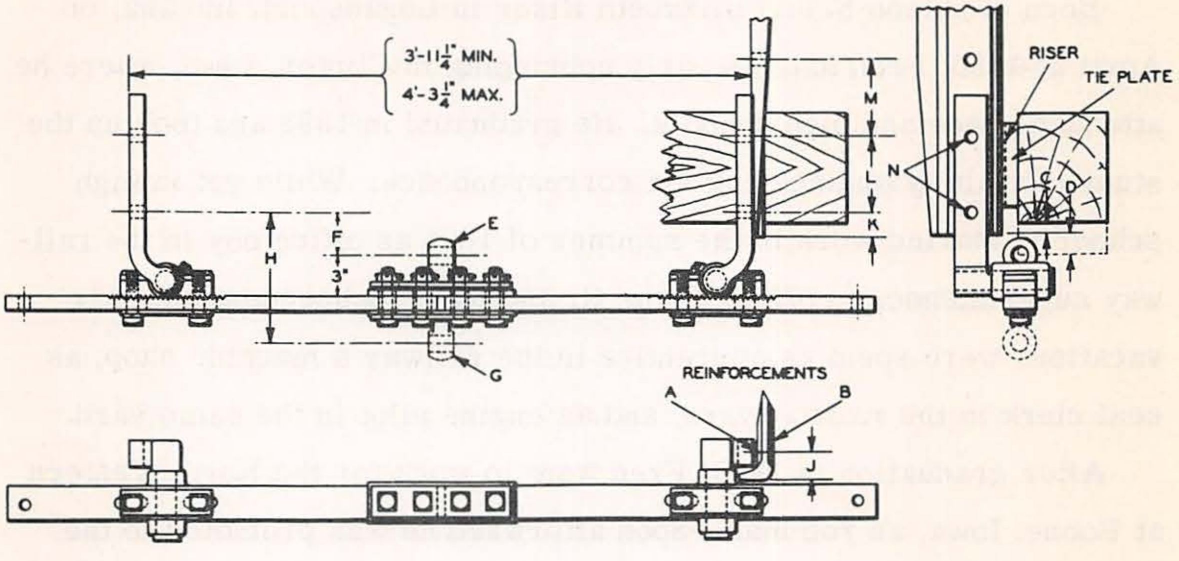
* * *

QUESTIONNAIRE FOR G-R-S HINGED FRONT ROD
(See Folder F134 dated July 1946)

When you order G-R-S hinged front rods, the following information is needed to enable us to furnish rods with the proper drilling and assembly to fit your switch layouts.

Railroad ______________________________ Date __________

Railroad Purchase Order No. ______________ Quantity ordered __________



1. Size and type of switch point rail: ______________________________

2. Thickness of reinforcement A ________ inches. Reinforcement B ________ inches.

3. Relation of point to tie: flush with tie ____. Ahead of tie, C ____ inches. Back of tie, D ____ inches.

4. Location of bracket: at E _____ F _____ inches. At G _____ H _____ inches.

5. Drilling of switch point : J _____ inches, K _____ inches, L _____ inches, M _____ inches.

6. Size of bolts: N _____ inch diameter. Slotted hole _____. Drilled hole _____.

7. Any other special information ______________________________

General Railway Signal Company
New York 17 Chicago 3 ROCHESTER 2, N.Y. St. Louis 1

Form 1201
M-437 12-46

Printed in U.S.A.

Fred Rizer Dies Unexpectedly

It was with shock and regret that we heard of the death of our Fred Rizer who passed away in New York City the night of November 26, 1946.

Fred had had a weak heart for some time, and had to be careful not to overdo. He had worked steadily right up to the last, being active in sales work out of the New York Office.

Born of Mason S. and Elizabeth Rizer in Logansport, Indiana, on April 5, 1880, Fred had his early upbringing in Clinton, Iowa, where he attended grade and high schools. He graduated in 1898 and took up the study of railway engineering via correspondence. While yet in high school he started work in the summer of 1895 as office boy in the railway superintendent's office on the C. and N.W. Subsequent summer vacations were spent as apprentice in the railway's machine shop, as seal clerk in the railway yard, and as engine pilot in the same yard.

After graduation in 1898, Fred went to work for the North Western at Boone, Iowa, as rod man. Soon afterward he was promoted to the position of instrument man. At the turn of the century he went back to eastern Iowa on the preliminary surveys for the Davenport, Rock Island and Northwestern. In 1901 he became assistant engineer* on the Rock Island where he devoted four years to construction and maintenance work on the Illinois, Kansas, and Nebraska lines. In 1905 he joined the engineering department of the C.B. & Q. as assistant engineer. He handled and inspected track materials and developed his ability in designing special track work such as frogs, switches, movable point layouts, guard rails and track appliances in general. His connection with the problems of track layouts arising at points of congestion, such as interlocking plants, brought him quite naturally into close contact with the apparatus used by the signal department. He took advantage of his opportunities to become familiar with interlocking and signaling. When J. B. Latimer, then signal engineer of the Burlington, had a position open for an inspector in December, 1910, Fred was appointed to that position. He handled a large amount of construction work which the Burlington had undertaken and, in the words of A. D. Cloud*, editor of the Signal Engineer (now Railway Signaling), "he showed considerable executive ability and talent for organization, together with the knack of getting along with his associates".

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* About this time (1901) our Al Moore, advertising manager, was helping to install a low-pressure pneumatic interlocking at Harrison Street, Chicago, on the Chicago Transfer Terminal. At a paralleling yard at LaSalle Street, Fred Rizer was running survey lines for the new terminal building, yet neither man was aware of the other's presence. Thirty years later Fred became assistant to A.G., as noted further in this write-up.

In 1913 Fred's ability as a writer of technical subjects had come to the attention of H. M. Sperry, who was then sales manager of our company at Rochester, N. Y. Fred had written a number of articles for the Railway Age Gazette (now Railway Age) and the Signal Engineer, mostly in connection with track work. Mr. Sperry offered him a position and on April 2, 1913 Fred joined G-R-S. During the war years he worked in commercial and sales engineering and in 1919 was appointed office engineer, New York.

In 1920 the need arose for G-R-S representation in South America and Fred was selected. He sailed out of New York July 17, visited several South American countries and returned to the U.S. in December of the same year, when he took up duties as sales engineer in our New York Office. He remained in that capacity until his death, except for four years (1931 to 1935) when he was assistant advertising manager in Rochester.

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* Brother of our Wilbur D. Cloud, eastern manager

Besides his interest in writing, Fred had devoted time to the study of higher mathematics, particularly in relation to astronomy; he had also absorbed six years of formal study of Latin, two of Greek, and had been exposed to the romance languages. With inquisitive intellect and keen interest, he kept abreast of world affairs be they scientific, cultural, political, religious or economic.

His associates in G-R-S will miss him deeply. Their sympathy particularly goes out to Mrs. Rizer and daughter Elizabeth in their heavy loss.

* * *

GENERAL RAILWAY SIGNAL COMPANY

G-R-S NEWS
December 1946

Train Communication

The Communications Section of the Association of American Railroads held its annual meeting in Detroit November 19, 20, and 21. At this meeting our Mr. William D. Hailes, electrical engineer, presented an interesting paper on the present status of space radio telephone as used in train operation. It is reproduced below for your information.

* * *

I. INTRODUCTION

A. Scope

This paper deals with space radio telephone as applied to the needs of railroad operation including the operation of railroad tugs in harbor service. A list of the more important uses of railroad radio will be followed by information concerning the equipment used, some of the problems encountered and the ways in which railroad radio is employed. No data on the "inductive carrier" type of train communication are included since that system is the subject of other papers to be presented at this meeting.

B. Definition

"Railroad radio" has come to mean a system that provides telephone communication between mobile stations on railroad rolling stock on the same or different trains, from wayside stations to these mobile stations and between certain wayside stations. Its main purpose is to assist in railroad operation, and the term will undoubtedly include the radio systems employed on railroad tugs and utility stations for special railroad needs and emergencies. Highly portable equipment such as walkie-talkies may ultimately form an important part of the complete system. By "railroad space radio" is meant the type of railroad radio that uses space radiation and does not require the presence of line wires for its operation.

C. Chief Uses

Railroad space radio has already proved its value in classification yards, in terminal areas, on tugboats and in main line service. The Federal Communications Commission recognizes the great need for space radio in railroad work and has modified its rules and regulations to facilitate the widest possible use of this means of communication in the business of running our railroad systems.

II. EQUIPMENT REQUIRED

A. The Essential Units

Referring now to the equipment employed, a typical railroad radio station has an equipment cabinet or case in which are housed the transmitter and receiver. It has a speaker, a handset or microphone, a control unit and an antenna. It also requires a source of power.

B. Transmitters and Receivers

Both AM and FM sets have been tested by several railroads and manufacturers. Both types have worked well, but FM sets are favored since they give better reception under less favorable signal-to-noise conditions, the receivers lend themselves to the application of the more satisfactory differential-action type of squelch circuit, and the inherent automatic volume control action of the limiter stages of an FM receiver tends to reduce the effects of signal strength flutter produced by multiple signal paths.

Transmitters giving upwards of 50 watts of **RF** power have been employed, but the trend is towards lower output power. Very satisfactory results have been obtained with 20 or even 10 watts of **RF** output when used with receivers having a sensitivity of approximately one microvolt. A receiver audio output in the order of five watts is often required for railroad use because of high ambient noise levels and the frequent need to operate multiple speakers.

C. Power Sources

The subject of power sources and conversion equipment to supply electrical energy for railroad radio sets is receiving earnest study and experimentation in an effort to develop the most satisfactory arrangements for the several kinds of stations. The problem can be described as the task of supplying approximately 150 watts steadily and about 250 to 300 watts intermittently. Part of this power is needed at low voltage for filaments and can be either a-c. or d-c. The remainder must be d-c. at voltages ranging up to 450 or 500 volts for plate circuits. One approach to the problem has been to design the radio sets to be powered by alternating current at the commercial voltage and frequency of 117 volts, 60 cycles, and, by means of power packs, supply the various loads therefrom. This scheme provides a high degree of standardization and interchangeability of radio sets but considerable power is wasted when 60-cycle energy must be obtained from a battery or other d-c. source. This is due to the fact that the efficiency of small motor-alternators is not much more than 50 percent and only about 70 percent for vibrator inverters. Furthermore, the vibrators used in currently available inverters have a rather limited and unpredictable life. This situation has lead to a search for a scheme that will retain the advantages of standardization and minimize the loss of power. The assignment is complicated by the variety of power sources that are encountered. For example, on steam locomotives the source may be a 117-volt, 60-cycle, turbo-alternator, but it will usually be a 32-volt d-c. turbo-generator. On Diesel locomotives, it may be 64 volts or 115 volts d-c. from a storage battery with a charging generator driven from the Diesel engine. Since electrical power is not generally available on cabooses, it must be provided. If a storage battery is employed, it will probably be a 32-volt battery with axle-driven charging equipment or terminal charging arrangements or both. If engine-driven generating equipment is used, it can supply either d-c. or a-c. or both forms of power. At present, I believe that engine-driven generators may play an important part in the solution of the power problem.

D. Antennas

Many types of antennas have been tested by various railroads and manufacturers. They have nearly all belonged to the class of antennas that produce vertically polarized radiation. The problem of staying within established clearance dimensions has resulted in a rather general use of the quarter-wave antenna for mobile units. Variations of the basic quarter-wave design have been used to effect a reduction in height or increased mechanical strength, or a completely grounded antenna. Since wayside antennas are not usually subject to clearance limitations, it is possible and customary to employ a half-wave antenna or a multiple-element array to produce greater useful radiation per watt of power. Multiple-element arrays have been designed with vertical directivity characteristics but a circular horizontal pattern to provide an improved general coverage; others have employed horizontal directivity to concentrate radiation in one or more particular horizontal directions. Combinations of horizontal and vertical directivity have been tried to produce maximum signal strength in one or two directions.

Yard engines are relatively small and therefore do not ordinarily present serious problems in finding a suitable place in which an antenna can be mounted. There is usually room within the clearance limits to mount a standard quarter-wave antenna or even a dipole coaxial antenna. Main line locomotives, however, present questions that have not been fully answered. The fundamental problem is to get an antenna that is short enough to permit mounting on a locomotive within very close clearance dimensions and, at the same time, not sacrifice too much in efficiency of operation. The shortest one that I know of is about seven inches high.

E. Housings

There are some rather special requirements placed on housings for railroad radio equipment. On mobile units dirt and water must be excluded and the radio equipment must be adequately protected from both vibration and severe shock. It is necessary that the radio units be held in place securely and, at the same time, be quickly removable. Quick-detachable features for making connections between the wiring in the housings and the radio units are necessary because of the very general practice in railroad operation of having one group of men do the maintenance and a different group do the repair work needed on the various units of equipment.

There are several places where the railroad radio housing or case can be mounted on a steam locomotive, but some of these locations are quite undesirable. The pilot is too rough riding to be suitable, above the smoke box is too hot, on top of the boiler is pretty hot and very inaccessible for servicing and the cab is usually too crowded. The tender offers several possibilities, and it gives a smoother ride than the engine. The need to carry wires across from the engine to the tender presents no new problems. Sturdy, water-tight plug couplers like those used successfully for years in train control systems are available for this work. On some tenders there will be room to mount the radio case at the side under the sill of the tender, or it can be set in a well built into the side of the tender just above the sill. Both of these locations are desirable because the radio equipment would be accessible from the ground, and it would not be subjected to rough riding. The tender deck can be used but the radio housing must be strong and water-tight enough to withstand occasional flooding with water from the filling spout or being buried in coal.

On Diesel locomotives, radio has been housed on the running-board but this is open to the objection that it is in the way. It has been mounted up in the nose of the locomotive when there was space, but each type of Diesel usually presents some new problem. The subject will require more study and preparation. I think it is safe to say that the cabinet or case for housing railroad mobile equipment must be strong, water-tight and capable of being mounted on a deck, against a wall, or underslung from an overhead structure. The mounting feet or brackets must be very sturdy to preclude any chance of mechanical failure.

F. Speaker, Handset and Control Unit

The satisfaction obtained from a railroad radio installation can be enhanced by using a speaker that has adequate power and good quality. Voices will sound more natural if some of the low frequencies come through. Speakers must also be well constructed to withstand the vibration and shock that are present on locomotives. There are such speakers on the market now. Standard handsets have been used with good success for fixed stations and mobile units. They appear to work well even in the presence of rather high noise levels. However, handsets with specially constructed transmitters and earpieces are available for use in noisy locations. For hump yard operation a microphone with an inbuilt push-to-talk button is more convenient than a handset, if the mike is supported on a flexible arm that brings it within easy reach of the engineman. It can be pushed out of the way after each transmission rather than requiring that it be carefully placed on a hook or hanger.

Control equipment includes the simple control unit used for local control as well as the more complex arrangements for one or more remote control points. A control unit usually houses the power switch, the volume control for the speaker, one or more indicator lamps and a dimmer control. The out-of-door control unit for a hump yard installation is a convenient location for the microphone and a husky push-to-talk lever. This combination is well suited to the way in which the hump conductor uses the radio. New problems in connection with remote control are being encountered and considerable development will be required to meet some of them.

G. Accessories

Accessories have been developed for use with railroad radio under certain operating conditions. One of these is a checking system applicable to hump yard operations. It has been tested over a period of 5 years and has been in use for over 2 years. In my opinion, it is a requisite for safe control of humping operations by radio alone. It is designed in accordance with the "Fail Safe" principle to warn the engineman of a hump locomotive if radio communication from the hump station should fail, so that humping operations can be stopped immediately pending reestablishment of communication.

Another accessory is selective calling, by which a particular mobile station can be brought into communication with the central station. Unquestionably, this feature will be appreciated when a large number of mobile units are operating in the same area and on the same frequency.

III. MODES OF OPERATION

A. Hump Yards

In hump yard service, the wayside station is located at the crest of the hump. From this point the hump conductor directs the activities of the "pusher" and "trimmer" engines. The operation of pushing a train over the hump is started with radio instructions to the pusher engine to get behind the train on track so-and-so. At this point, the pusher engine is perhaps two miles from the hump, but by means of the two-way radio the hump conductor and engineman on the pusher engine are able to cooperate as readily as if they were within speaking distance. Details are quickly arranged and when all is ready the train is pushed up the hump. When the leading end arrives at the crest, the hump conductor begins separating the train into "cuts" of one or several cars, each cut bound for a particular classification track into which it rolls by gravity. It is during these humping and cutting operations that radio does a most effective job. It is not possible to give enough information by wayside signals to enable the hump conductor and the pusher engineman to work to full advantage under all conditions. For example, when a coupler pin sticks, the radio saves much time by enabling the hump conductor to tell the pusher engineman just what is happening at the hump. If the radio is equipped with a self-checking system, it can be used safely to continue humping operations during periods of low visibility when it is not possible to see wayside signals.

B. Terminal Areas and Tugboats

In a terminal area railroad radio is used to provide two-way phone communication for the train- or yard-master with the locomotives working under his supervision. If a large number of locomotives are in use at one time, it may be advantageous to use a selective calling system so that only the locomotive with which communication is desired need hear the message.

For tugboat service, radio is used by the tug dispatcher in supervising and directing tugs as they move about a harbor performing a variety of duties. Changing weather and unexpected local conditions greatly affect operations in tugboat service. But with radio, the tug dispatcher talks directly with the tugboat captain and orders are revised promptly to meet new conditions, and communication between tugs can often play an important part, during regular service and in case of emergency.

C. Main Line, End to End and Point to Train

Train operation on main lines probably offers the most romantic parts for railroad radio to play. It is the application to this service that has caught the public interest and can be the most exciting. It is not too hard to imagine a variety of situations which will be reported by railroad radio in time to avoid serious damage or delay. I know of one instance in which a station agent saw that a load of heavy timbers on a flat car had broken loose and were pounding the car ahead. He immediately reported it to the dispatcher and the train was notified by radio of this dangerous condition. The engineer was given full information about the situation, he made a normal stop, and no timbers were dislodged. The conductor saw that it would be necessary to set out the car and radioed this information to the dispatcher along with the car number and other details needed to expedite setting out the car and having the shifting load secured again. Furthermore, in this case, it is possible that the railroad radio may have prevented serious accident, because the train was stopped before any of the timbers had shifted far enough to foul traffic on the adjacent track or to fall off the car.

Perhaps this was a rather unusual opportunity for railroad radio, but there are many regular operations in main line service for which radio is needed.

Trains in the same vicinity will be able to talk to one another and to one or more wayside stations. On freight trains, end-to-end phone communication will permit the train crew to handle their train much more effectively, particularly under adverse weather and operating conditions. Time will be saved in preparing a train for departure and when entering and leaving sidings and many other places enroute where it helps to know just where the other end of the train is, so as to clear switches or road crossings, or to spot a crippled car that must be set out before serious trouble starts. These are some of the things that railroad radio in end-to-end and point-to-train service can do, day in and day out, to earn its keep.

* * *

Train Communication Exhibit

An exhibit of G-R-S train communication equipment was set up in the Statler Hotel, Detroit, for the A.A.R. Communications Section meeting, November 19 to 21. The following was displayed:

1. Typical wayside cabinet with space radio transmitter, receiver, and a wayside check unit.
2. Mobile cases with space radio transmitter, receiver, and a mobile check unit.
3. Antennas, 1/4-wave and 1/2-wave.
4. Microphone.
5. Speaker.
6. Handset.
7. Control unit.
8. Loop tuning unit.
9. Plug coupler (for coupling circuits between engine and tender).
10. Inductive carrier transmitter and receiver.

Specially designed tables decorated in magenta and emerald green, with chrome-plated legs, made a harmonious support for the apparatus, some of which was mounted on pedestals bearing descriptive data. A backdrop of sepia murals depicting actual installations completed the display. Folder F135 briefly describing the inductive carrier and space radio systems was distributed to the Section members. A copy is attached for your information.

* * *

Train Communication Movie

A quarter-hour color silent movie on train communication, entitled "Railroad Space Radio", has been prepared and was shown in Detroit before the AAR Communications Section as an accompaniment to Mr. Hailes' lecture, which is reproduced elsewhere in this issue.

The film shows the uses made of radio communication in the Mechanicville and Selkirk classification yards and in New York harbor on railroad tugs. The operating advantages are stressed rather than the details of each piece of equipment.

The movie was planned, filmed, and edited by our advertising department with the whole-hearted cooperation of the Boston and Maine and the New York Central railroads.

* * *

Congestion on the Airways

Two articles have appeared recently in the Saturday Evening Post commenting on the airway traffic jam and describing the systems proposed for relieving the situation.

In the October 19 issue an anonymous airline pilot of considerable experience tells the writer, Wesley Price, "Why Air Passengers Get Mad." He explains that air schedules invariably bog down when bad weather closes in over our major airports. Landings and take-offs come to a virtual standstill. He states that means are available to keep planes moving into and out of airports, but full use has not been made of them. He blames governmental red tape, specifically the Civil Aeronautics Board and the Civil Aeronautics Administration, for the jam.

In the October 26 issue, in an article titled "Let's Let the Airlines Fly", Wesley Price estimates that traffic tie-ups are costing the airlines $25 million yearly. He goes on to describe the various systems which may clear the air:

1. Instrument-landing system (ILS). The CAA's development.
2. Ground control approach (GCA). The Navy's system.
3. Teleregister (Teleregister Corp., a Western Union Affiliate).
4. Teleran (Radio Corporation of America).
5. Navar (International Telephone and Telegraph).
6. The Block System (General Railway Signal Company).

Price states that none of the systems has had a complete test in civil aviation, but that this winter CAA is going to try out instrument-landing systems in about 100 cities, and hopes to have 79 in operation by January.

Despite their tone of gripe, these articles do serve to shed light on the airway problems and draw the public's attention to the need for action. Air traffic growth has been so rapid that it is not surprising that the airlanes are being choked. There has hardly been time to develop and manufacture control systems which would meet the requirements both efficiently and economically.

* * *

The Block System for Airway Traffic Control

Airway traffic control first had our attention back in 1938 when we designed a stepper system for correlating plane altitude information between control tower operators and plane dispatchers. Since that time we have devised and installed the ADF (automatic direction finding) approach control system.

Our latest contribution to air traffic control is a complete block system to provide space separation between planes on all altitudes, for one-way or two-way traffic, for airway junctions and crossings.

Even while the October 19 issue of Satevepost (mentioned elsewhere in this NEWS) was being distributed, our Messrs. Wight and Field were in Indianapolis describing "The Block System for Airway Traffic Control" to the world-wide delegation at the PICAO* meeting. Slides were shown illustrating the fundamental principles of the system and pamphlet 630, bearing the same title, was distributed to the delegates. This pamphlet is the basis of an article on "The Block System" to appear in the December issue of Electronic Industries.

Because of our close association with railway traffic control we are in the unique position of being able to apply to airway operation the basic principles which we have developed and tested in railway operation over nearly a half-century. In addition, new electronic techniques are also available to us to span the air gap between plane and ground controls.

* * *

Field, Wight Commissioned Fleet Admirals

"Know ye that

Oscar S. Field

Sedgwick N. Wight

are hereby commissioned

Admirals of the Flagship Fleet

In recognition of consistent and meritorious service which

has contributed materially to the development of air

transportation as a public service . . ."

So read the certificates presented to Messrs. Field and Wight over the signature of Fleet Admiral C. R. Smith, chairman of the American Airlines System. G-R-S research on airway traffic control, which merited this citation, is mentioned elsewhere in this issue.

* * *

GENERAL RAILWAY SIGNAL COMPANY

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* Provisional International Civil Aviation Organization.

TRAIN COMMUNICATION SYSTEMS

FOLDER F135
November 1946

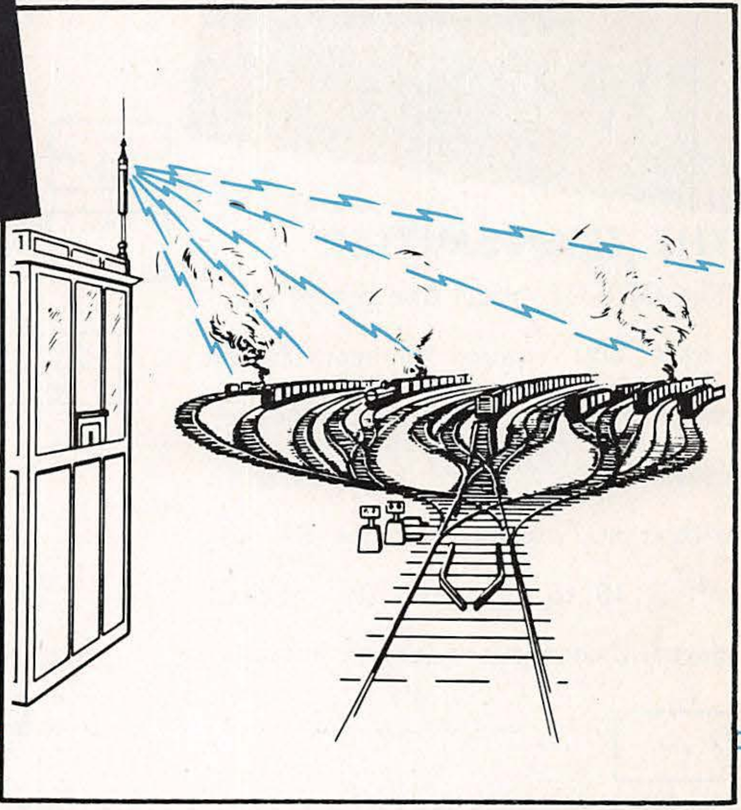
GENERAL RAILWAY SIGNAL COMPANY
ROCHESTER, N. Y.

Printed in U.S.A.

Copyright 1946

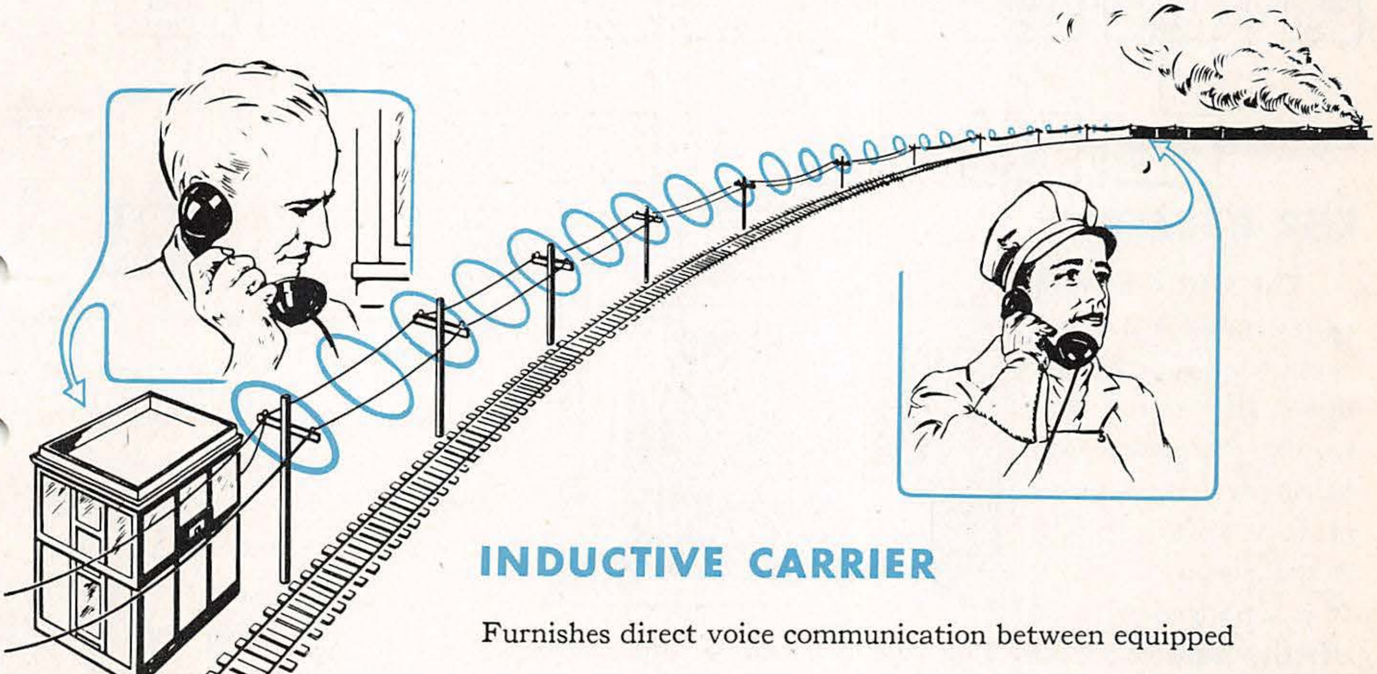
A GRS-GE Train Communication System keeps this engineman in direct contact with the hump.

TWO systems of GENERAL RAILWAY SIGNAL GENERAL ELECTRIC TRAIN COMMUNICATION



VHF RADIO

Furnishes direct voice communication between equipped units, fixed or mobile, by VHF space radiation. Particularly suited to end-to-end, yard and terminal, and harbor operations.



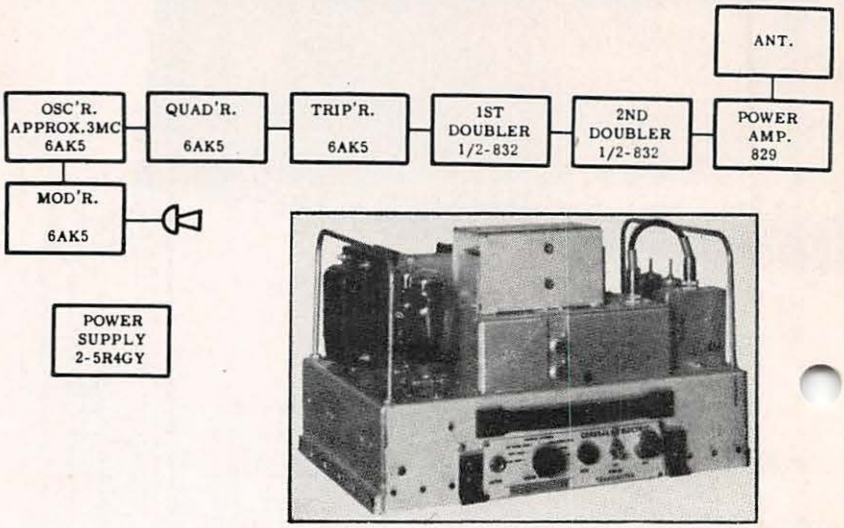
INDUCTIVE CARRIER

Furnishes direct voice communication between equipped units, fixed or mobile, by carrier current guided along wayside wires. Particularly suited to wayside-to-train and wayside-to-wayside, and train-to-train communication.

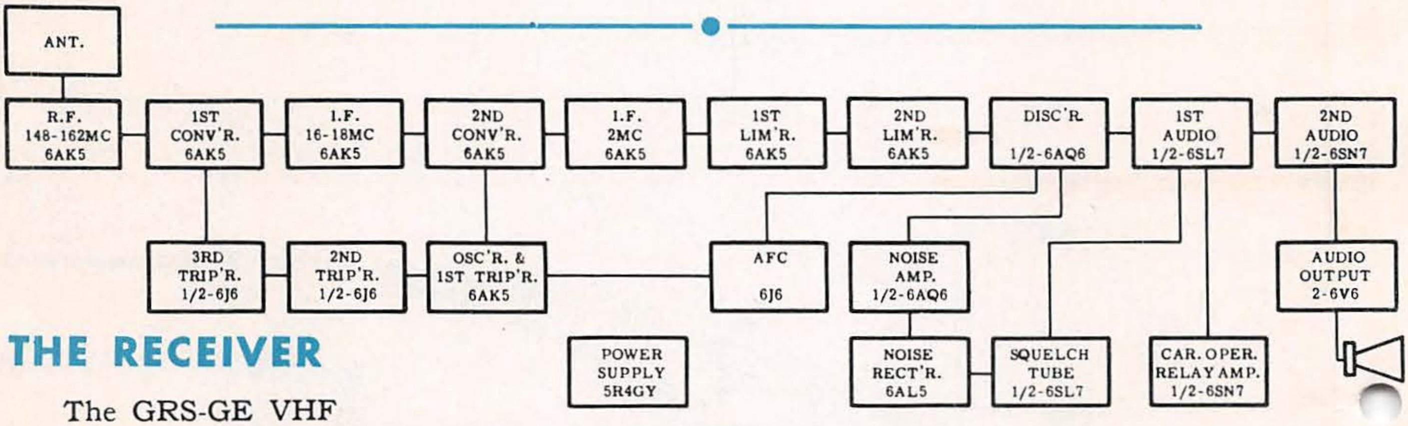
GRS-GE VHF RADIO

THE MAJOR

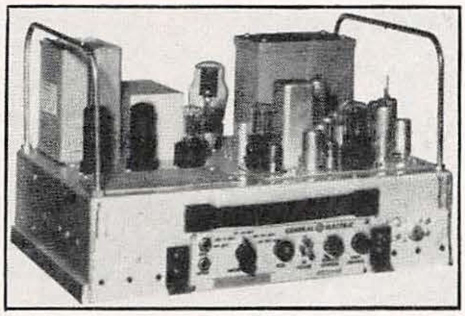
THE TRANSMITTER


ANT.
OSC'R. APPROX. 3MC 6AK5
QUAD'R. 6AK5
TRIP'R. 6AK5
1ST DOUBLER 1/2-832
2ND DOUBLER 1/2-832
POWER AMP. 829
MOD'R. 6AK5
POWER SUPPLY 2-5R4GY

The GRS-GE VHF transmitter operates at any required frequency in the range 156-162 megacycles. Frequency modulation (±15 kc. swing) is used, with crystal oscillator control. RF output is 15 to 25 watts. All required electrical connections (except antenna) are automatically made through a built-in plug connection when the transmitter is placed on its shock mount.


ANT.
R.F. 148-162MC 6AK5
1ST CONV'R. 6AK5
I.F. 16-18MC 6AK5
2ND CONV'R. 6AK5
I.F. 2MC 6AK5
1ST LIM'R. 6AK5
2ND LIM'R. 6AK5
DISC'R. 1/2-6AQ6
1ST AUDIO 1/2-6SL7
2ND AUDIO 1/2-6SN7
3RD TRIP'R. 1/2-6J6
2ND TRIP'R. 1/2-6J6
OSC'R. & 1ST TRIP'R. 6AK5
AFC 6J6
NOISE AMP. 1/2-6AQ6
AUDIO OUTPUT 2-6V6
POWER SUPPLY 5R4GY
NOISE RECT'R. 6AL5
SQUELCH TUBE 1/2-6SL7
CAR. OPER. RELAY AMP. 1/2-6SN7

THE RECEIVER



The GRS-GE VHF receiver is a double conversion superheterodyne, with crystal control of the local oscillator. Sensitivity is approximately 1.0 microvolt. Audio output, 5 watts. It is equipped with an effective squelch circuit. Like the transmitter, all required external connections (except antenna) are automatically made through a plug connector on the shock mount.

ANTENNAS

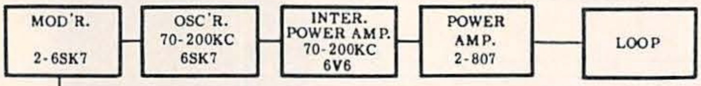
A single antenna serves both transmitter and receiver at each location. The coaxial dipole is standard for fixed stations; for mobile use either the dipole or ¼ wave ground plane type may be used.

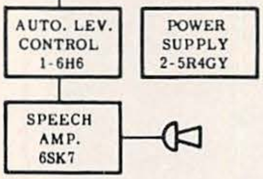
¼-wave Ground Plane

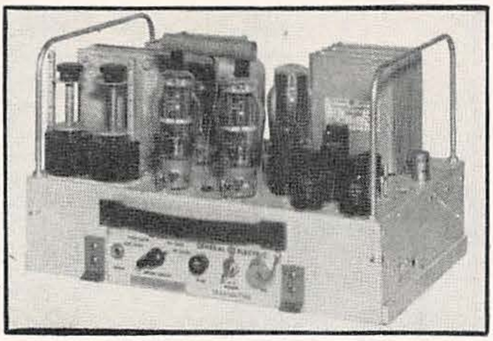
½-wave Coaxial

EQUIPMENT

GRS-GE INDUCTIVE CARRIER


MOD'R.
2-6SK7
OSC'R.
70-200KC
6SK7
INTER.
POWER AMP.
70-200KC
6V6
POWER
AMP.
2-807
LOOP


AUTO. LEV.
CONTROL
1-6H6
POWER
SUPPLY
2-5R4GY
SPEECH
AMP.
6SK7

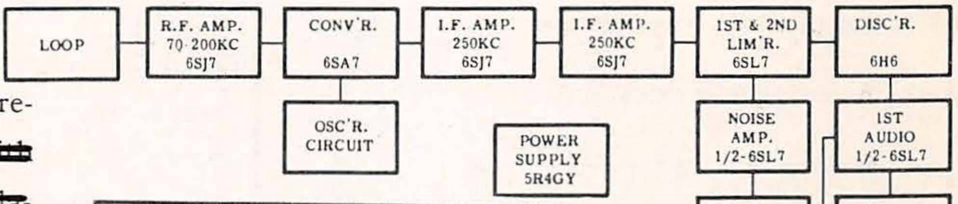


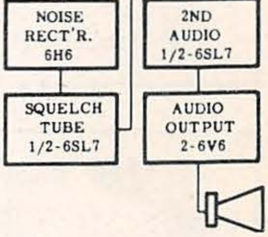
THE TRANSMITTER

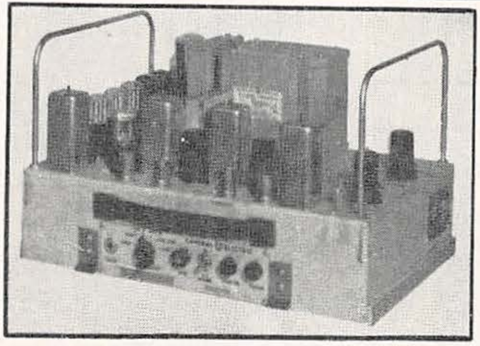
The GRS-GE inductive carrier transmitter operates at any required frequency in the range 70-200 kilocycles. Frequency modulation is used ~~with crystal oscillator control~~. Output is approximately 30 watts. All connections are made automatically through a plug-connector built into the chassis which engages a mating unit on the shock mount.

THE RECEIVER

The GRS-GE inductive carrier receiver is a superheterodyne. ~~with crystal control of the local oscillator.~~ Sensitivity is approximately 1.0 microvolt, and output 5 watts. It is equipped with an effective squelch circuit. Automatic plug-in connection is used, as on the transmitter.

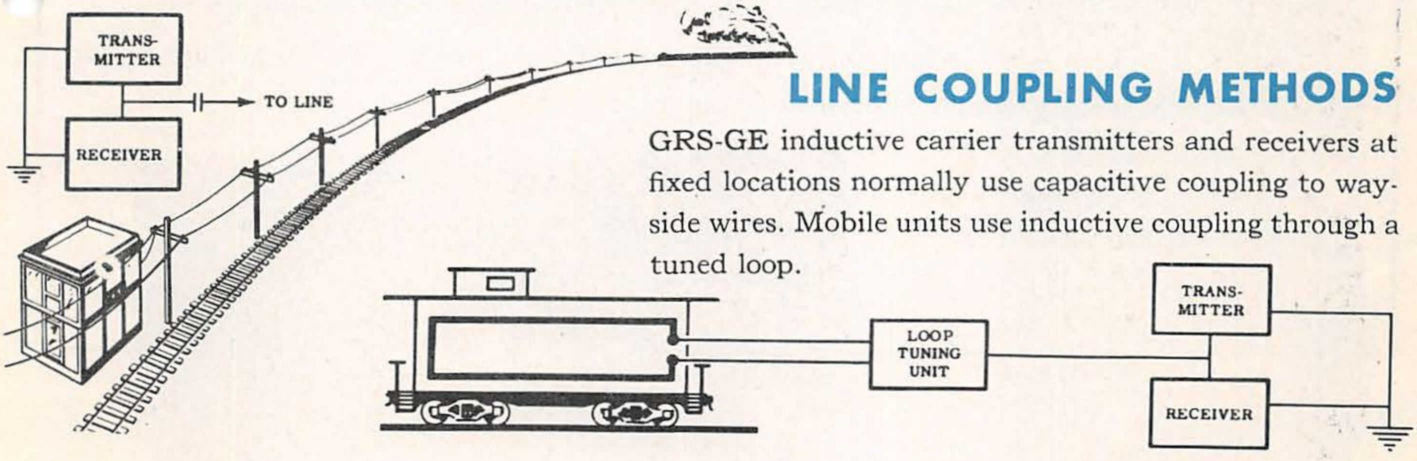

LOOP
R.F. AMP.
70-200KC
6SJ7
CONV'R.
6SA7
I.F. AMP.
250KC
6SJ7
I.F. AMP.
250KC
6SJ7
1ST & 2ND
LIM'R.
6SL7
DISC'R.
6H6
OSC'R.
CIRCUIT
POWER
SUPPLY
5R4GY
NOISE
AMP.
1/2-6SL7
1ST
AUDIO
1/2-6SL7


NOISE
RECT'R.
6H6
2ND
AUDIO
1/2-6SL7
SQUELCH
TUBE
1/2-6SL7
AUDIO
OUTPUT
2-6V6



LINE COUPLING METHODS

GRS-GE inductive carrier transmitters and receivers at fixed locations normally use capacitive coupling to wayside wires. Mobile units use inductive coupling through a tuned loop.


TRANS-
MITTER
TO LINE
RECEIVER
LOOP
TUNING
UNIT
TRANS-
MITTER
RECEIVER

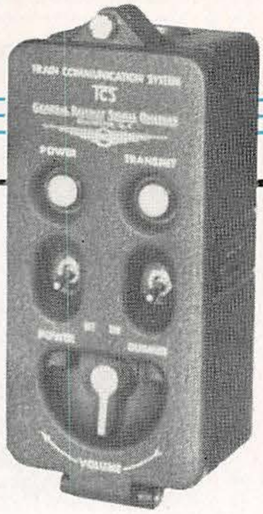
AUXILIARY EQUIPMENT

Used by both VHF Radio and Inductive Carrier

THE HANDSET

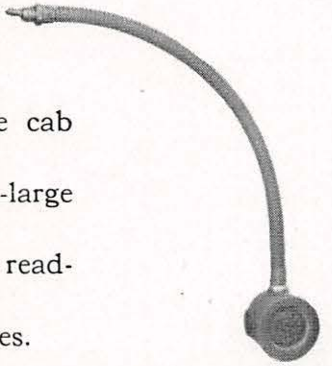
is telephone type, with push-to-talk button. Sidetone is provided when transmitting.

THE CONTROL UNIT



Contains main power switch, power-on light, "transmit" light, dimmer switch for lights, and volume control for the speaker.

THE FLEXIBLE MICROPHONE



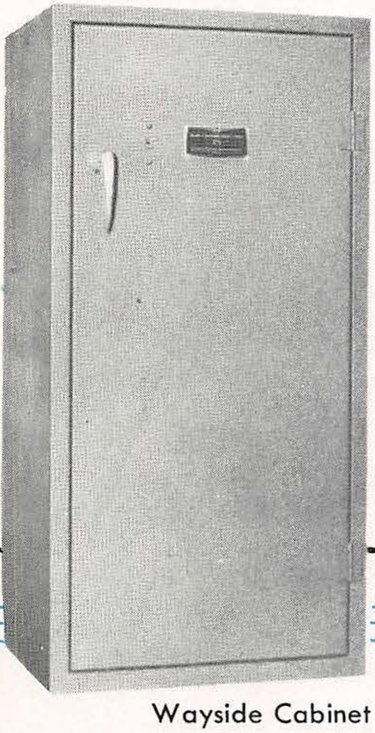
designed for engine cab mounting, has extra-large push-to-talk button readily usable with gloves.

THE SPEAKER

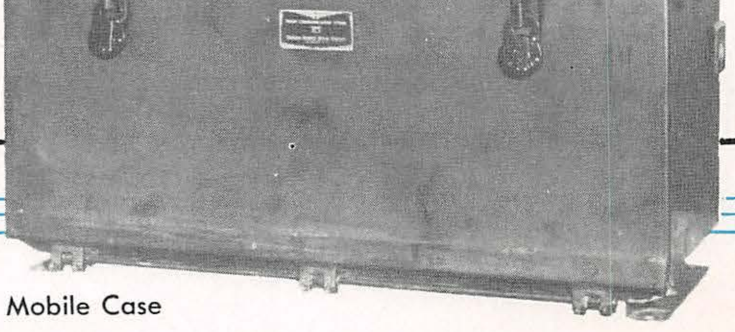
used for calling, has a permanent magnet dynamic unit with folded exponential horn. It is rugged, weatherproof, and has good response to voice frequencies.

THE EQUIPMENT CASES

are designed to protect equipment and facilitate maintenance. Mobile type is heavy steel, weatherproof, intended for locomotive, tender, or caboose mounting. Wayside type is sheet steel, dustproof. Both types are equipped with shock mounts to minimize vibration, and with automatic plug connections for making circuit connections to equipment.



Wayside Cabinet



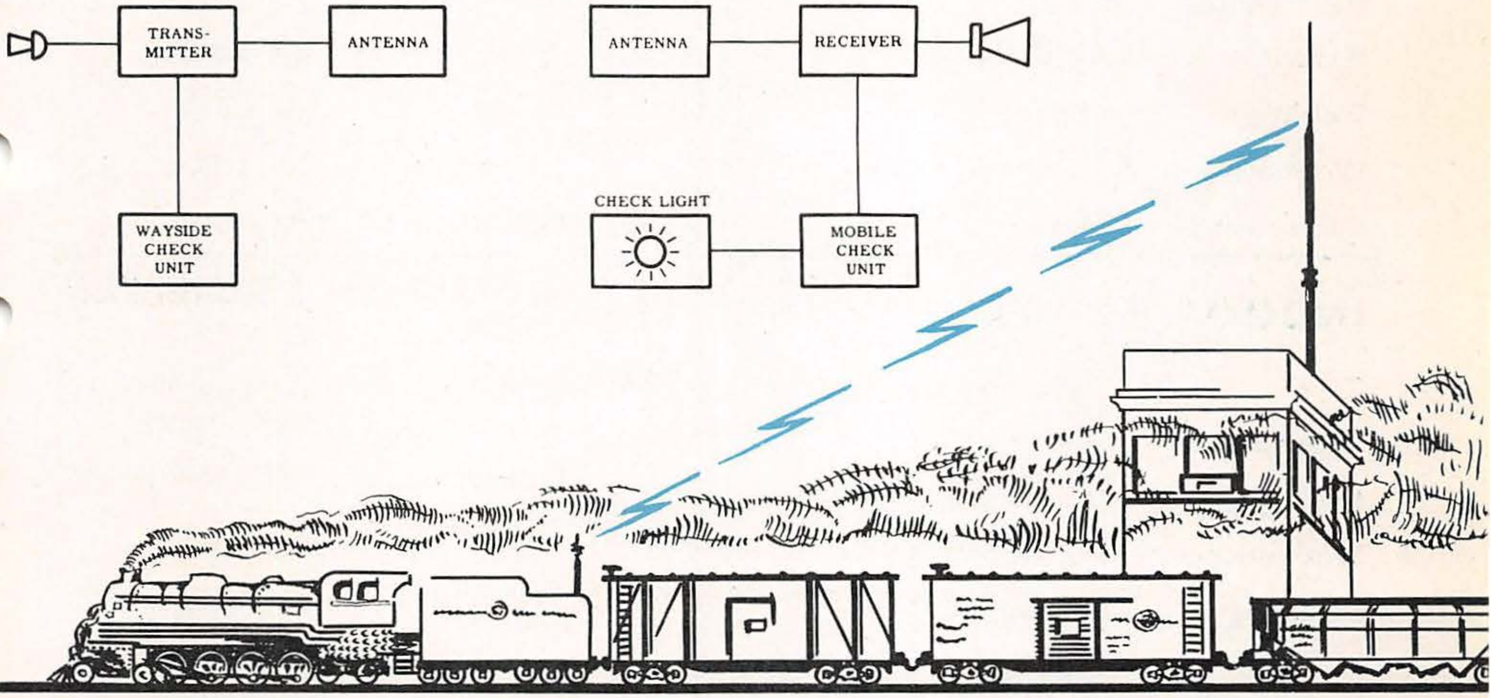
Mobile Case

G-R-S CHECK SYSTEM

The GRS Check System is a special feature developed by the General Railway Signal Company for GRS-GE Train Communication Systems employed in hump yard service, especially when the T.C.S. is used to control pusher and trimmer engine movements without auxiliary signals. The GRS Check System is designed to provide assurance at all times to enginemen on equipped locomotives that the Train Communication System is in working order, and that it may be relied upon for instructions governing movements of their engines or trains.

The check system applies closed-circuit principles to Train Communication. A 6000 cycle note, automatically transmitted at regular intervals from the hump station, is filtered out of the locomotive receivers, and used to energize circuits which light a check light on the locomotive control unit. Any failure which prevents proper transmission and reception of the check signal results in the check light's going out, warning the enginemen of possible trouble in the communication system.

The check signal in no way interferes with routine use of the communication system.



CONDENSED DATA

VHF RADIO TRANSMITTER

Frequency Range:	156-162 mc.
Modulation:	FM
Power Output:	25 watts
Power Input:	
Standby:	70 watts
Transmit:	225 watts
Weight:	50 pounds
Dimensions:	16″ x 11½″ x 10½″
Connections:	Plug-in

VHF RADIO RECEIVER

Frequency:	Fixed to match transmitter
Type:	Double conversion superheterodyne; local oscillator crystal controlled.
Sensitivity:	1.0 microvolt
Audio Output:	5 watts
Power Input:	100 watts
Weight:	40 pounds
Dimensions:	16″ x 11½″ x 10½″
Connections:	Plug-in

INDOOR EQUIPMENT CASE

Type:	Sheet steel, dustproof
Dimensions:	20½″ x 18″ x 42″
Finish:	Wrinkle green
Wire entrances:	For 1¼″ fittings
Mounting:	Floor or table
Locking:	Built in

INDUCTIVE CARRIER TRANSMITTER

Frequency Range:	70-200 kc.
Modulation:	FM
Power Output:	30 watts
Power Input:	
Standby:	70 watts
Transmit:	225 watts
Weight:	50 pounds
Dimensions:	16″ x 11½″ x 10½″
Connections:	Plug-in

INDUCTIVE CARRIER RECEIVER

Frequency:	Fixed to match transmitter
Type:	Superheterodyne, ~~local oscillator crystal controlled~~.
Sensitivity:	1.0 microvolt
Audio Output:	5 watts
Power Input:	100 watts
Weight:	40 pounds
Dimensions:	16″ x 11½″ x 10½″
Connections:	Plug-in

OUTDOOR EQUIPMENT CASE

Type:	Heavy steel weatherproof
Dimensions:	37″ x 18⅞″ x 19″
Finish:	Black
Wire entrances:	For 1¼″ fittings
Mounting:	Deck, bracket, or underslung
Locking:	Padlock

G-R-S NEWS

November 1946

The Future of Signaling

At the AAR Signal Section meeting held in Swampscott, Mass., October 14, 15, and 16, our Mr. Oscar S. Field, director of research and engineering, made a provocative prognosis on signaling. His speech is reproduced below.

* * *

This is an attempt to encourage forward thinking in the signal profession even to the extent of what may now appear to be visionary. Our experience to date has proven that someday some of the apparently impractical things happen, and we wonder why we thought them impractical in the past.

Looking backwards at the railroad signaling profession we cannot be otherwise than profoundly impressed with the tremendous technological progress that has been made.

In the early days of signaling, if a signal engineer had common sense and was mechanically minded, he could get by - but today this is no longer true.

The signaling art today is highly technical, and a signal engineer must have high technical skill and training and a working knowledge of many branches of engineering and associated sciences.

As the electrical arts have progressed, railroad signal engineers have consistently taken advantage of the available developments to expand and improve their signaling equipment up to the present day's highly refined system of signaling.

Railroading of today has become a very intricate business and, with the progressive increase of traffic, increase in weight and speeds, the use of refrigerator cars, automatic stokers, etc., the signaling problem has continuously become more and more difficult.

In spite of these increasing difficulties, the profession has consistently kept ahead, and we are doing things today that in the initial stages of the profession would have been staggering if not considered quite impossible.

Transportation is continuously growing. New forms of transportation have come into the field such as the motor truck and aeroplane, all of which have set up new standards of competition that must be met.

Electronic techniques are steadily entering the signal field, and we find an urgent necessity to expand our technical skills to keep up with the advancing arts.

I would like to review briefly some of the various lanes and by-ways of the traffic signaling and safety control business generally, and try to visualize some of the problems yet to be solved and the possible trends of future development in this field. I realize that, in so doing, I am laying myself open to the charge of being visionary but, being among friends, I am hoping that I will not be too severely criticized.

We may start off with the one fundamental device that has been and still promises to be, for a long time, the foundation of traffic safety controls - the track circuit.

In its original conception by Robinson in 1872, it appeared to be a quite simple device. As the art progressed, we ran into many problems. Ballast leakage has become increasingly more difficult to handle and, in addition, we encountered electric propulsion and many other problems which necessitated the continuous development of better d-c. and a-c. relays and operational techniques.

Perhaps the latest version of track circuiting in the railroad field is the coded track circuit. This has introduced a new set of additional problems such as timing, storage battery effect, speed of operation and the like.

Present track circuit practices are at an extremely high stage of refinement and while undoubtedly minor detailed improvements will be made from time to time, I do not look for any fundamental changes in the near future. Try to imagine a traffic control system today without the employment of a track circuit. The aeronautical field is facing the problem, and, I suspect, would feel quite secure if track circuits were available to them. The railroads are quite fortunate in having this tool in its present highly developed form for their use, and it will undoubtedly continue to be the basis of all automatic railroad signaling for a long time to come.

While the track circuit is the foundation of our present signaling practices, it is nevertheless still not the perfect device we would all like to see. In all our track circuits there is the problem of rail resistance or conductance. This involves, in addition to rail resistance, the problem of bonding. A great many different types of bonding are now in use, all of which have certain outstanding points of merit, but the perfect bond has yet to be found. Then we have the ballast leakage to contend with. A minimum ballast leakage of 4 ohms per 1000 feet at one time was thought to be the bottom limit on main line track circuits. This is no longer true; today, we are experiencing ballast leakages as low as 0.5 ohm per 1000 feet and the top limit is still at infinity. Real imagination and originality is needed to overcome this handicap and maintain reliable track circuit operation.

There is another difficulty which has become more apparent with the advent of the coded track circuit, and that is the so-called "storage battery effect." It manifests itself as a continuation of current flow between the rails of a track circuit after all sources of energy have been completely disconnected. This is a very serious handicap in track circuit performance, and the problem should be given a great deal of consideration.

In coded track circuits, there is room for original work on the problem of elimination of code distortion. This, of course, is necessarily tied up with the track circuit characteristics to which I have just referred.

I have made no mention of the relays employed in track circuits, power supply for track circuits, nor the problems involved in alternating current track circuits. I have merely indicated some of the outstanding things to show that there is still room for a great deal of original thinking on the track circuit problem.

It is, of course, possible that a track circuit equivalent of some nature may be developed in the future which may replace the present track circuit entirely. By this, I do not mean refinements in the track circuit itself such as substitution of electronic tubes for relays and the like, but have reference to possible completely new substitutions.

It is conceivable that the presence of a train in a block might be detected by the use of some form of modern radar pulse techniques.

I recognize the many problems involved such as getting around curves, isolation of controls from one block to another and between the tracks, and the like. These problems, today, look insurmountable but, out of such thinking, may come the germ of an idea that is of extreme value to the signaling art.

I would be embarrassed at this point if someone asked me how it could be done, but this only serves to illustrate the point that I am merely trying to visualize future possibilities, which is something quite different from our immediate future problems.

As you all know, block signaling antedated the track circuit. It originated in the form of manually operated balls and lanterns which were replaced with manually operated semaphores and the lock and block or some such method of traffic regulation.

The old Hall Company introduced automatic Banjo Signal operation by means of the so-called "Nigger Head" treadle instrument, which was in turn replaced by the track circuit. Electrical operation of semaphores came into vogue, and, with the combination of these with the track circuit, we had the groundwork for all forms of present day automatic block signaling.

We went through the throes of lower- and upper-quadrant signaling, color-light signaling, position-light signaling and color-position-light signaling. All of these different types of signaling depend upon visual transmission of their indications and operate under quite severe handicaps during inclement weather.

We have had discussions on the relative merit of position versus color indications with their charges and counter-charges of color blindness on the one hand and astigmatism on the other hand.

The majority of you, no doubt, will remember the advent of the position-light signal, the cure for all color blind problems, also the counter opposition claim that color-light signals were not subject to the effects of astigmatism, and then later the introduction of the color-position-light signal.

Light signals of one type or another seem to be the favored present-day practice. The power required for their operation frequently becomes quite a problem. The optical efficiency is quite low, not better than 25 percent in most signals and in no case exceeding 35 or 40 percent.

Approach lighting has gone a long way to solve the power problem but improvements in optical systems, both as to distribution of light flux and also efficiency, are worthy of consideration.

It seems to me, however, that more attention might be given to one fundamental defect in all of these wayside signals. They are all dependent upon visual transmission of the indication and hence are severely handicapped in inclement weather conditions.

Is it too much to hope that someday in the future we may be able to produce a new type of roadside signal that will be free from this defect?

It is quite possible that a projection unit might be developed that would project electro-magnetic waves in lieu of light waves that might be detected or seen regardless of weather conditions. Again this sounds a little bit visionary, but visionary ideas are the stimulus to progress.

Let's consider the matter of line wire. We all have a very comfortable feeling when we can see an actual wire stretched between a control point and the junction to be controlled, and perhaps shudder a little bit at the thought of eliminating this more or less substantial physical connection.

On the other hand, we are faced with **the proposed action of the telegraph** companies to eliminate line wires and use radio relay links for transmittal of information. There are certainly many arguments in favor of the radio relay line. It provides a multitude of communication channels, is free from the hazard of sleet storms and is claimed to be very economical.

We will always have the power problem with us, and it is difficult to see how we can entirely get rid of transmission lines for this purpose. Reliable local sources of supply and suitable standby equipment are a partial answer. Improvement in standby equipment therefore becomes an essential requirement in our progress toward the elimination of line wires.

After first cost, maintenance seems to be the major item for consideration. Line wire failures invariably occur at a time when weather, usually sleet and icy conditions, make repairs a very difficult and hazardous procedure.

In the case of the radio link, we have the problem of equipment failures to face. I assume that the major source of failure would be in the radio tubes. These are being continually improved and their life expectancy increased.

By a suitable replacement schedule, failures of this type should be reduced to a minimum, and, in the event that a failure does occur, the simple replacement of a tube, an operation performed inside a building and out of the weather, should be simplicity itself compared to a line wire repair.

At the present time, as a part of a signal system, it looks a bit wobbly, nevertheless we cannot afford to completely ignore its possibilities. We may discover the radio relay link to be quite a useful tool for our use.

Intermittent and inductive train control and cab signaling are another major line of development. There are still various schools of thought on this subject and to try and predict the future trend at this time is a difficult undertaking. In the past, there have been many different ideas suggested varying from high-frequency radiation from wave guides all along the way to permanent magnetic devices and mechanical trippers. Some have stood the test of time and assumed their proper position in the picture, others have fallen by the wayside.

Cab signals have proved their value and, with the definite trend towards increased speeds, will be used to a greater extent. More indications will be required as the use of cab signals is extended and we should be thinking of ways and means of accomplishing this without unnecessary additional complication and expense.

Speed control, as an adjunct to train control, has been considered in the past and is now used to a limited extent. There are definite advantages to speed control but, owing to the complications involved, its use has only been justified to a limited extent. New ideas along these lines that would simplify the necessary equipment might quite reasonably justify its extended use.

Automatic braking application is an art in itself. The problem of making a proper application in accordance with actual running conditions of the train is difficult, but we undoubtedly will see definite improvements along these lines.

Extended use of electronic techniques in the train control field is well worth consideration. The fundamental problem in train control is the establishment of a controlled communication link between the roadside and the moving vehicle. New wartime techniques should open up new avenues of thought along these lines.

As an indication of what is now going on along these lines, we might take another look at the air industry. The Army is today operating automatic control of planes, guiding a plane into an airport, landing the plane and shutting off the engines entirely without any action on the part of the pilot. Can we anticipate such a control on our trains? It is quite within the bounds of possibility.

Interlocking is a subject that has had a varied career. We started out with mechanically operated devices with their pipe lines and wire connections.

The perfection of automatically operated signals and switch machines made possible the development of remote controls, which made available systems of electric interlocking. The next step in the development of interlocking has been toward simplified fully automatic traffic controls as exemplified in our latest systems of route interlocking.

It looks as though mechanical locking has been relegated to the past. The route, or relay interlocking, is new and, if history repeats itself, will be subject to many changes and improvements for quite a while to come. This is a subject on which it is well worth applying some original thought.

In this progressive development, we see a definite trend toward fully automatic control of trains. We already have automatic route selection through the agency of a few manually controlled push buttons. Perhaps in the future we will see the trains themselves automatically selecting their own route through an interlocking. This, of course, would involve many problems such as train identification and traffic selection, but we have solved many problems in the past that, at the time, looked equally difficult.

Superimposed on our automatic control of signals we have dispatching.

This has developed into what is known as Centralized Traffic Control. From the unit wire system we have progressed to the point where we have coded control over a small number of line wires together with carrier control to more remote locations. There is an increasing demand for increased capacity which, in turn, introduces new transmission problems and the desirability of speeding up operation.

Techniques of transmission and coding should be carefully analyzed. It is quite possible that new and better means may be found.

Simplification of equipment and circuits should be the keynote. Any ideas that would accomplish these results would be of great value.

There has been some talk of radio operated centralized traffic control, and there may be some justification for such a step somewhere in the future. We certainly should not lose sight of the possibility, however remote.

We have now entered into the new era of train communication. There are two types of equipment - one known as "inductive carrier", and the other as "space radiation". Both systems have basic advantages and no doubt will assume their proper place in the future. The whole art, as applied to railroading, is too new to permit any definite conclusions.

We can be sure, however, that end-to-end train communication and train to wayside communication are here to stay, and may have a profound influence in the future trend of the signaling profession. There are many problems to be solved. For instance, the building of radio equipment that is rugged enough to stand up on a locomotive, a power supply for radio in cabooses, check systems, etc.

In addition to basic systems, we should also keep before us the desirability of improvement in the components in such systems.

Take relays for instance. We have progressed from the original simple telegraph relay to a widely diversified group of devices particularly designed for many specific applications. There is still room for improvement in contact performance and improvements in working values. The advent of electronics will necessarily introduce new and different relay requirements; in fact, thermionic tubes may in some cases actually replace relays as we now commonly know them.

New types of relays are called for. For instance, relays used in signal circuits are not suitable for use in centralized traffic control systems which necessitated the development of a new and different line of relays for this work. On the other hand, neither of these types were suitable for coded track circuit applications. As the signaling art progresses, we must expect demands for still other types of relays having characteristics foreign to any of those which we now have.

The relay field presents opportunities for extensive flights of the imagination. It is one basic group that we can feel sure will always be involved in our many progressive developments. Even radio applications require relays.

There are switch machines, switch circuit controllers, signals, transformers, and a multitude of other devices which go into the making of a complete signal system. All of these devices can be improved as our knowledge of the sciences progresses.

Out of a whole lot of original thinking usually come some few valuable ideas. Let's not forget the possibility of an improved track circuit or a track circuit equivalent, light signals that will penetrate fog, possible elimination of line wire, possible fully automatic control of trains, wireless dispatching, the effect of communications on the whole signaling field, and any other ideas that may occur to us. Today, they may be wild - tomorrow, they may be practicalities.

Imagination costs nothing. It is something we can all indulge in and, very frequently, with worthwhile results.

Out of the many thoughts that we may have, there are bound to be some valuable ideas which, if pursued, will eventuate in practical advances being made in our profession.

While we are worrying away at our present-day problems, let's take a look ahead once in a while; it pays.

* * *

Recipe for Better Coils

1. Extract moisture from coil under vacuum.
2. Flood cold varnish into tank to overflowing.
3. Apply pressure (100 p.s.i.) to force varnish into pores.
4. Drain and bake.
5. Serve up a better-insulated coil.

All of which is another way of saying that we are now using a vacuum varnish pressure treatment for coils which go into our transformers and bonds. We are discontinuing the varnish dip because service tests show that we can produce a better coil the new way. The varnish used is glycerine phthalic anhydride - glyptal for short.

* * *

New Relay Oil

Our laboratory announces that they have found a new oil for relays and fine instruments. This oil, known as "Fine Relay Oil 51347-10 Gr 1" is a highly refined mineral oil and meets our specification MS2-186.

For our applications we consider the new oil superior to the Nye's Delicate Machinery Oil, formerly used, in that at high temperatures it will not become rancid, nor cause chemical interaction between dissimilar metallic parts which are in close contact.

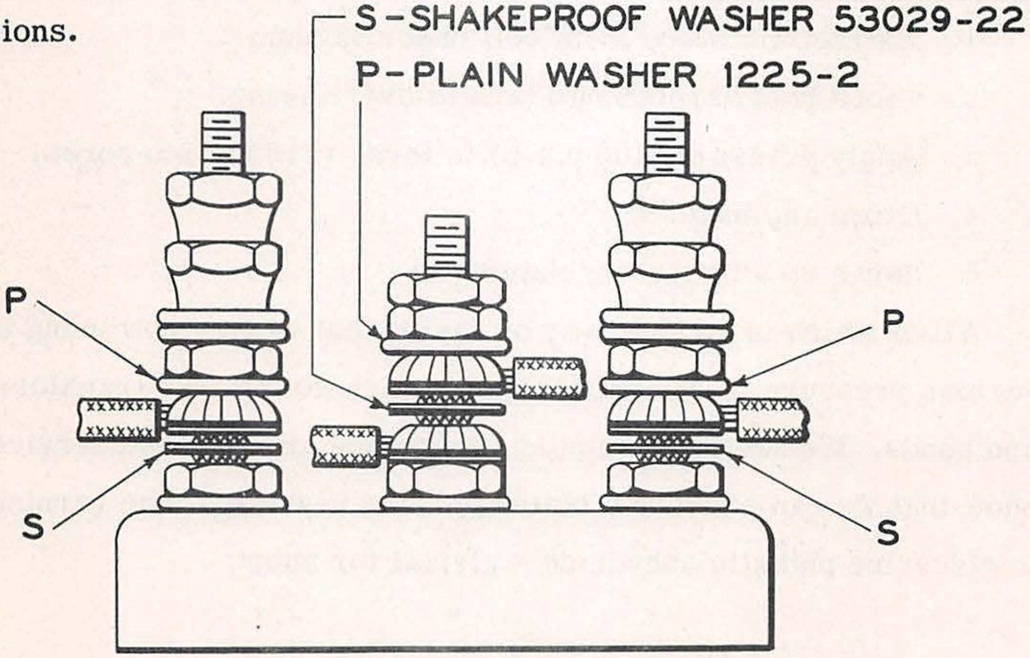
There may be relay and instrument repair shops in your district which may be interested. The oil is put up in 1/2-ounce containers.

* * *

New Coil Terminal Assembly for K Relays

All coil terminal assemblies on our Type K relays will be equipped with a bronze shakeproof washer under all single eyelets and a bronze shakeproof washer between eyelets at the center connection.

Tests in use have indicated that this will materially improve the coil connections.



G-R-S NEWS

October 1946

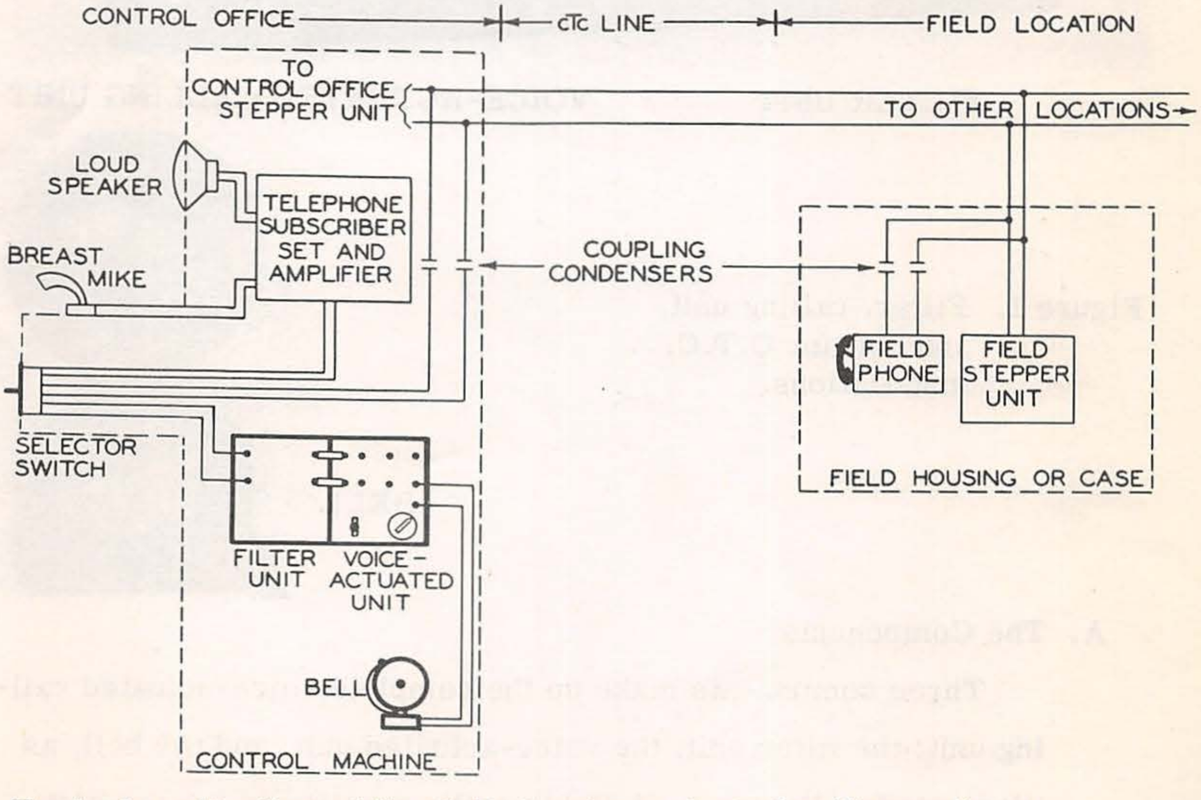
Any or all of the material contained in this article may be used for publication, but a release must first be obtained from the Boston and Maine publicity department.

* * *

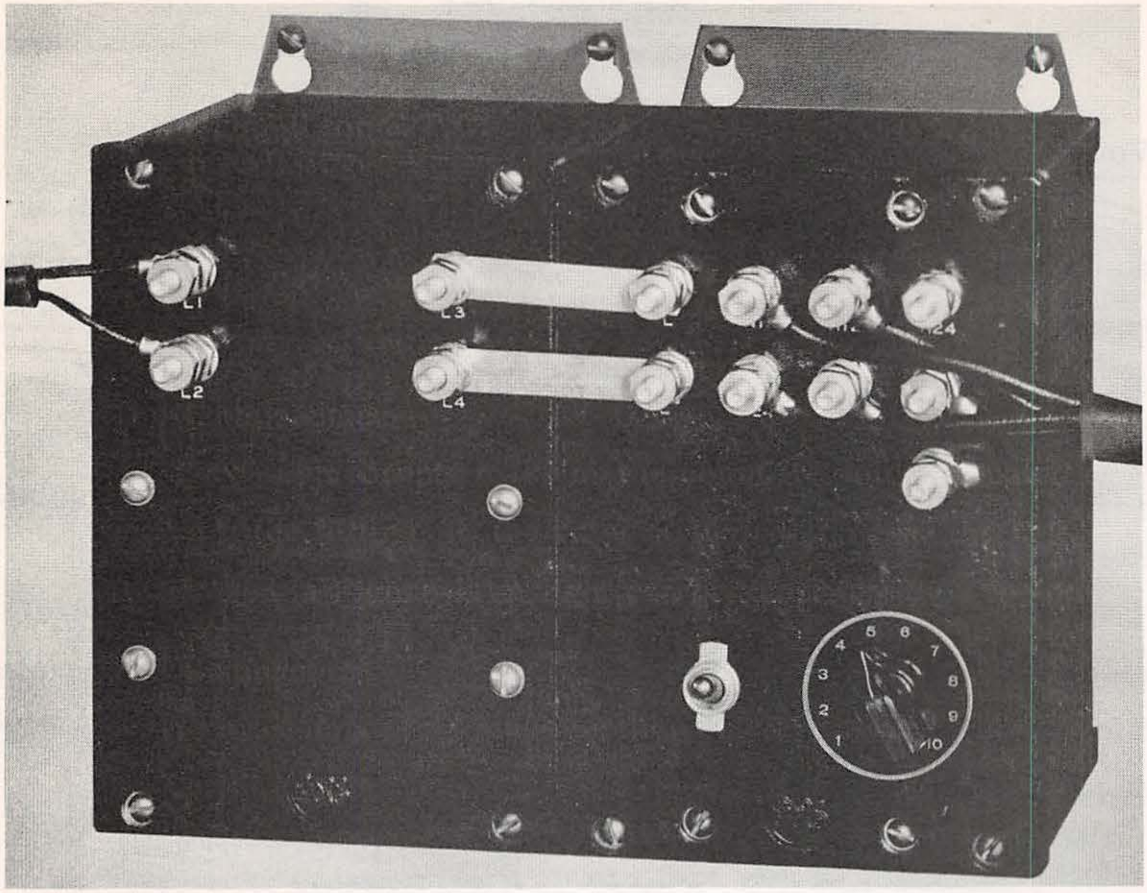
Voice-Actuated Calling Unit

Recently tested and in production, a voice-actuated calling unit is now available. When connected to a pair of C.T.C. line wires (which are equipped for telephone), this device makes it possible to call the C.T.C. operator to his telephone from any location out in the field without the use of magneto ringers, etc. on the field telephones. A maintainer or a trainman, simply by speaking into his field telephone, can cause a bell to ring or a light to light in the control office.

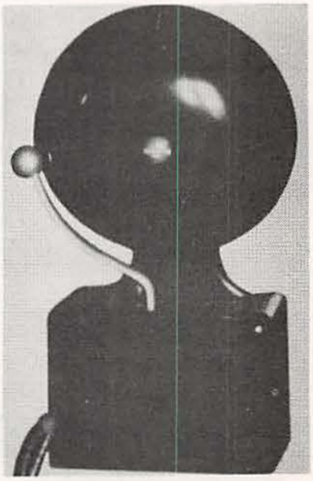
The voice-actuated unit, in effect, is a monitor of lines which are used only occasionally for calling the C.T.C. operator. It enables maintainers and train crews to use the C.T.C. lines without burdening a busy dispatching circuit.


CONTROL OFFICE
CTC LINE
FIELD LOCATION
TO CONTROL OFFICE STEPPER UNIT
TO OTHER LOCATIONS
LOUD SPEAKER
TELEPHONE SUBSCRIBER SET AND AMPLIFIER
BREAST MIKE
COUPLING CONDENSERS
FIELD PHONE
FIELD STEPPER UNIT
SELECTOR SWITCH
FIELD HOUSING OR CASE
FILTER UNIT
VOICE-ACTUATED UNIT
BELL
CONTROL MACHINE

Typical application of the G-R-S voice-actuated calling unit.



FILTER UNIT VOICE-ACTUATED CALLING UNIT

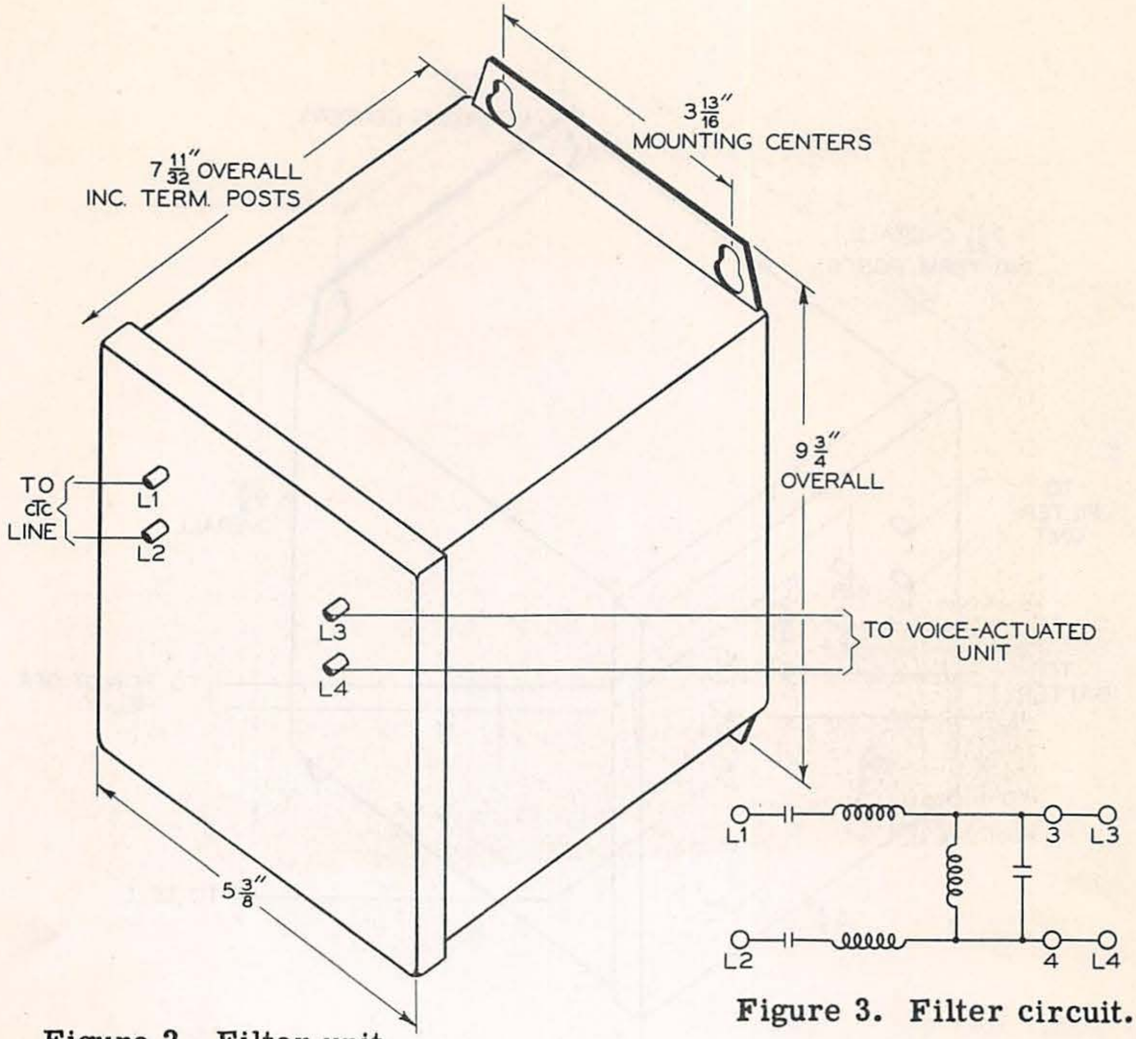


BELL

Figure 1. Filter, calling unit, and bell for C.T.C. installations.

A. The Components

Three components make up the complete voice-actuated calling unit; the filter unit, the voice-actuated unit, and the bell, as illustrated in Figure 1. A light can be substituted for the bell.


7 11/32" OVERALL
INC. TERM. POSTS
3 13/16"
MOUNTING CENTERS
9 3/4"
OVERALL
TO
CTC
LINE
L1
L2
L3
L4
TO VOICE-ACTUATED
UNIT
5 3/8"

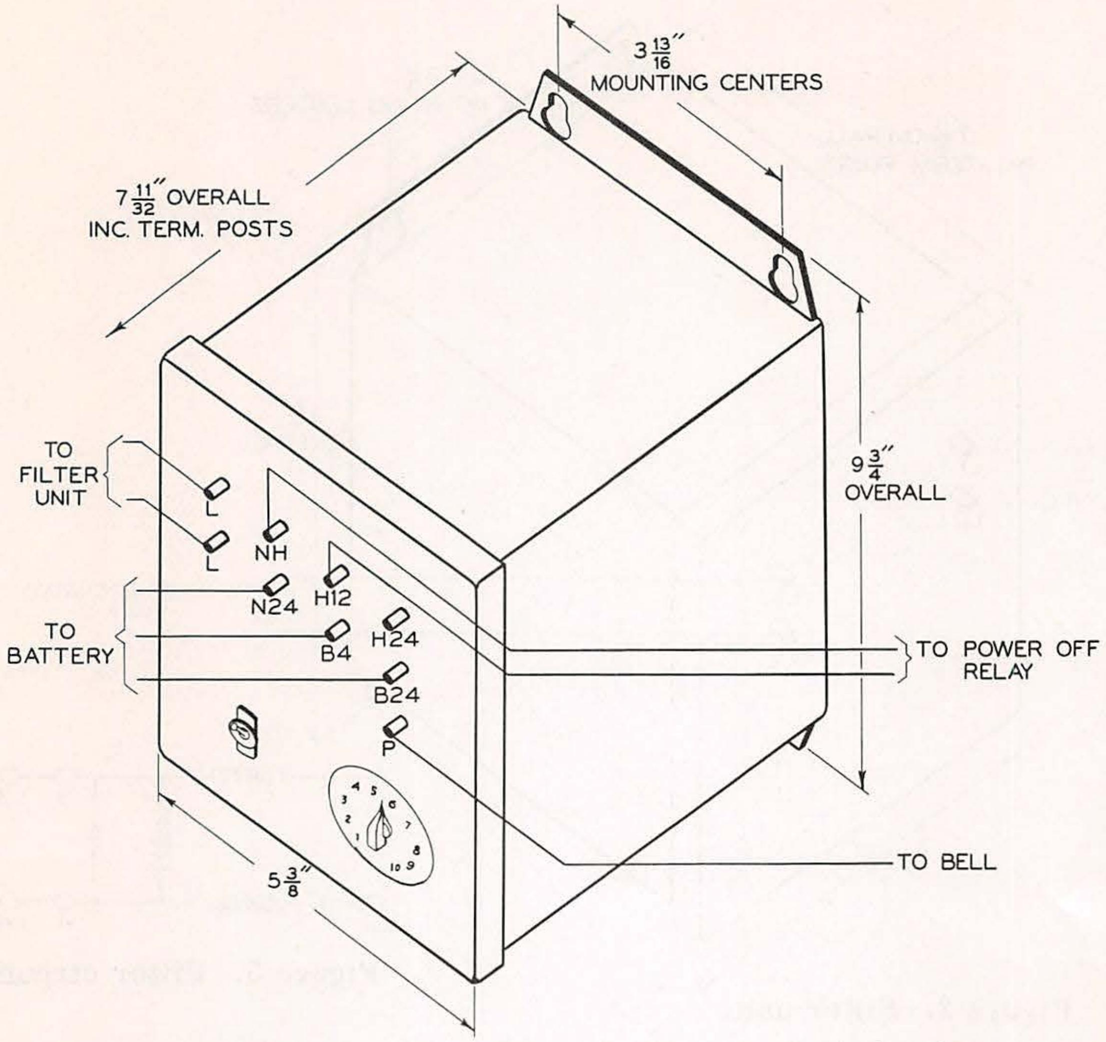
L1
3
L3
L2
4
L4

Figure 3. Filter circuit.

Figure 2. Filter unit.

1. The filter unit, 58496

As can be seen in Figure 2, the filter unit consists of a rectangular box which contains coils and condensers connected to form a filter which passes only the band of frequencies which are to operate the device, i.e. those frequencies from about 500 up to 1600 cycles. The filter unit is connected on the one side through a suitable switch box to the line wires, and on the other side to the voice-actuated calling unit. The circuit is given in Figure 3.



$3\frac{13}{16}''$ MOUNTING CENTERS
$7\frac{11}{32}''$ OVERALL INC. TERM. POSTS
TO FILTER UNIT
L
L
NH
H12
N24
TO BATTERY
B4
H24
B24
P
$9\frac{3}{4}''$ OVERALL
TO POWER OFF RELAY
TO BELL
$5\frac{3}{8}''$
1
2
3
4
5
6
7
8
9
10

Figure 4. Voice-actuated calling unit.

2. The voice-actuated unit, 58657

This unit, also a rectangular box, houses the amplifier tube (Type 6F8G), the gas tube (Type 2050), and the ballast tube (Amperite 6H-11), besides the input transformer, resistors, and condensers. See Figure 4.

The circuit is given in Figure 5. Note that the only power required is that supplied by the 24-volt C.T.C. local battery.

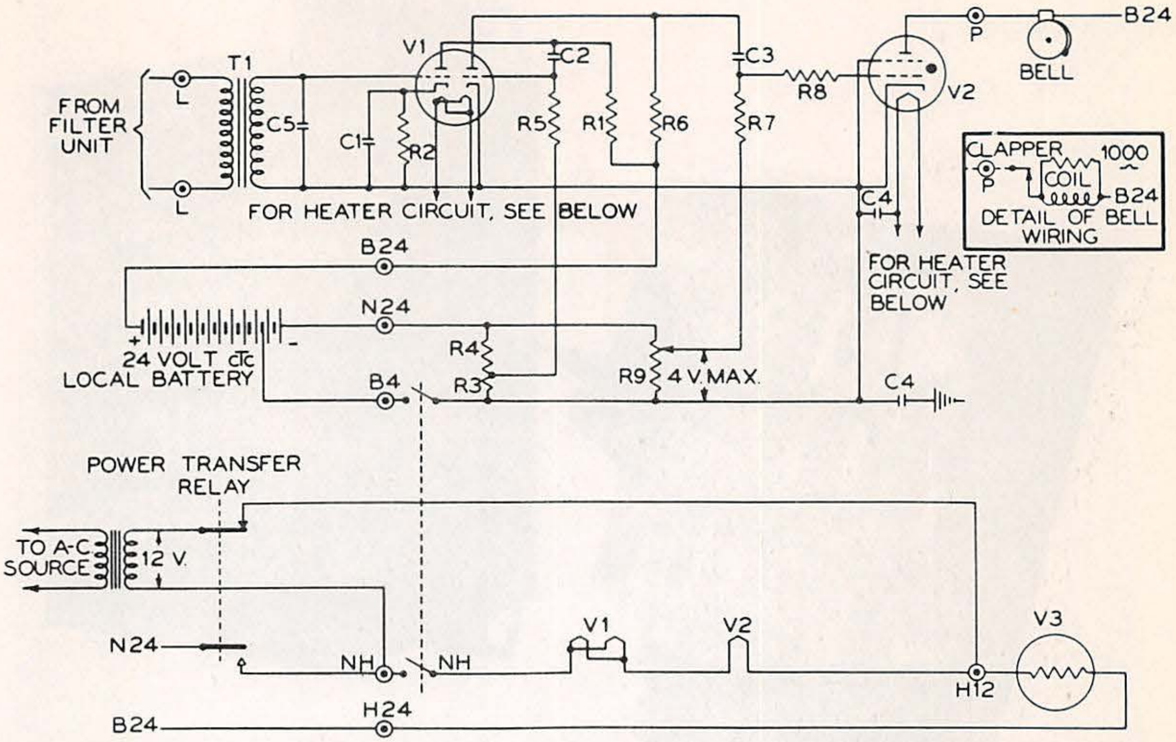

FROM FILTER UNIT
L
L
T1
C5
C1
R2
V1
C2
R5
R1
R6
C3
R7
R8
V2
P
BELL
B24
CLAPPER
1000 ~
COIL
P
B24
DETAIL OF BELL WIRING
FOR HEATER CIRCUIT, SEE BELOW
C4
FOR HEATER CIRCUIT, SEE BELOW
B24
N24
24 VOLT CTC LOCAL BATTERY
R4
R3
B4
R9
4 V. MAX.
C4
POWER TRANSFER RELAY
TO A-C SOURCE
12 V.
N24
NH
NH
V1
V2
V3
H12
H24
B24

Figure 5. Circuit of voice-actuated calling unit. Tube heaters can be connected to battery or to a 12-volt transformer secondary, as shown, if a power-transfer relay is provided.

T1	INPUT TRANSFORMER
V1	TYPE 6F8G TWIN TRIODE
V2	TYPE 2050 GAS TETRODE
V3	AMPERITE 6H-11 BALLAST

RESISTORS	OHMS	WATTAGE
R1	470,000	1/2
R2	68,000	1/2
R3	10,000	1/2
R4	15,000	1/2
R5	1,000,000	1/2
R6	100,000	1/2
R7	47,000	1/2
R8	10,000	1/2
R9	5,000	2

CONDENSERS	MICROFDS	VOLTAGE
C1	0.05	400 d-c.
C2	0.002	500 d-c.
C3	0.5 - 0.5	600 d-c.
C4	0.5 - 0.5	600 d-c.
C5	0.001	600 d-c.

The 6F8G tube is a twin-triode amplifier. It is used to amplify the voice signals which are received from the field over the C.T.C. line. The 2050 tube, a gas tube, is normally biased below the firing point by a 4-volt tap off the 24-volt C.T.C. battery. When voice signals are received and amplified, the gas tube fires and causes the bell to ring or the indication light to light.

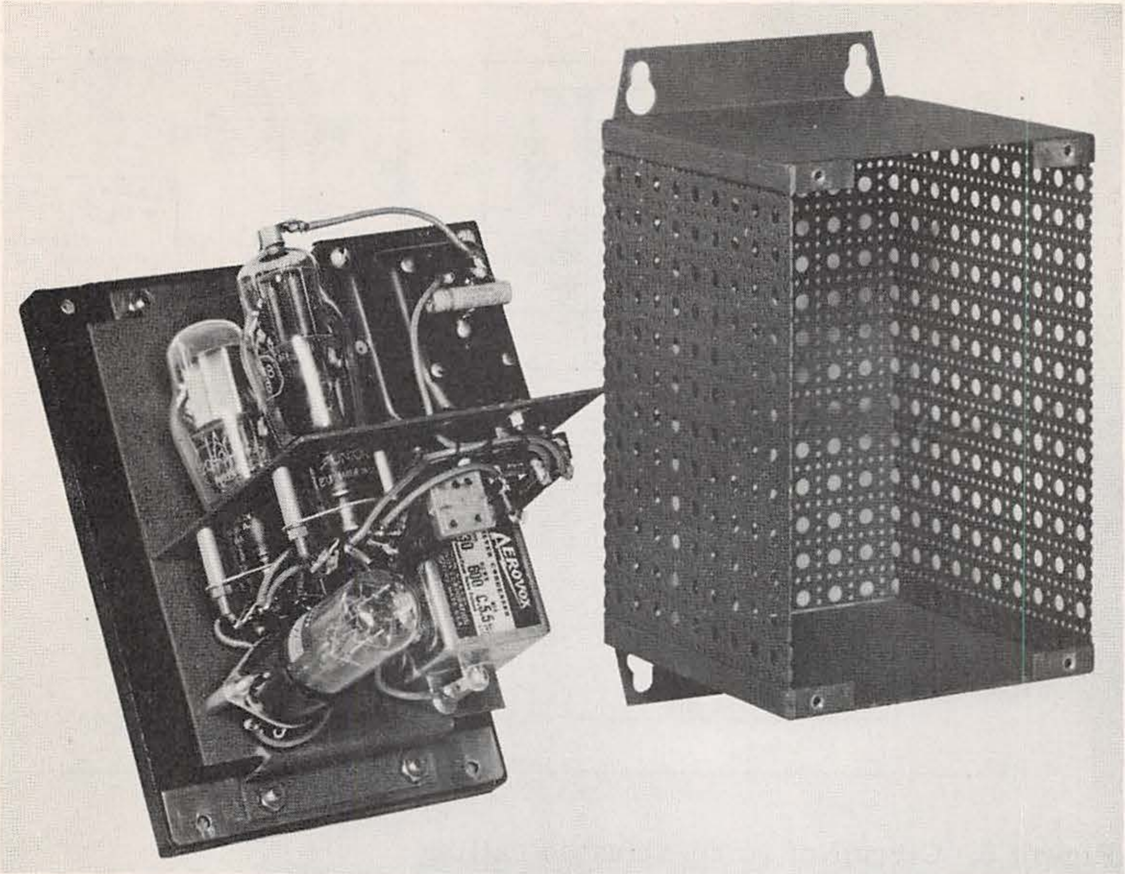


Figure 6. The calling unit is removed from its case for access to tubes

As soon as the voice signals die away, the gas tube quits firing and bell stops. The light, if used instead of the bell, will stay lit until a manual reset switch is actuated. This feature may be desired in the event that the operator goes out of the room beyond hearing distance of the bell.

3. The bell, 53938-10

The bell is connected to the plate of the gas tube, and has the standard vibrating clapper. To prevent undesirable feedbacks into the power wires the energy of the bell coils is absorbed by a 1000-ohm resistor connected in shunt across the coils.

B. How the Calling Unit Works

1. With no incoming voice waves

By referring to Figure 5, which shows the circuit of the calling unit, it can be seen that there is a charge of approximately 22 volts across condenser C3, with the negative side of the condenser connected to the control grid of gas tube V2. A grid bias voltage of approximately 4 volts negative with respect to the cathode keeps the gas tube well below the cut off point where it cannot fire.

2. With voice-frequency currents being received

At the moment a maintainer calls in over the C.T.C. line wires, the voice-frequency currents are passed through the filter and through the primary of the input transformer T1. The presence of these currents causes an oscillating voltage to be applied to the left-hand grid of the twin-triode amplifier tube V1, allowing plate current to flow during the entire cycle of the applied a-c. wave (Class A amplification). Plate current flows through load resistor R5 and coupling condenser C2.

The voltage drop across resistor R5 is in such a direction as to cause the right-hand grid of tube V1 to swing positive, thus allowing the right half of V1 to conduct.

Before the voice oscillations start, condenser C3 carries a charge of approximately 22 volts, with the top plate positive (in Figure 5). During voice reception when the right half of V1 starts to conduct, there is a drop across resistor R6, which in effect lowers the voltage across C3 causing it to discharge. The discharge current path is from the upper plate of the condenser, through R6, the battery, part of resistor R9, and upward through resistor R7, back to the lower plate of the condenser. The drop across R7 is in a direction to lower the control grid potential of tube V2, which still prevents it from firing.

When, however, the right-hand grid of V1 swings negative with the voice oscillation, the right half of V1 cuts off, there is no drop through R5 and condenser C3 again charges up to the full 22 volts which it had when the line was quiescent. The charge current path is from the lower plate of the condenser, downward through resistor R7, through part of resistor R9, the battery, resistor R6, back to the upper plate of the condenser. This time the voltage drop across R7 is of such polarity as to swing V2's control grid positive and cause it to fire, thus ringing the bell.

The bell will continue to ring as long as the filter continues to pass voice-frequency currents which cause V2's control grid to go positive with respect to its cathode.

As soon as the voice currents cease, V2's control grid goes negative. The gas tube ceases ionizing when the clapper contact in the bell opens, cuts off the plate voltage to the tube, then closes and finds that the control grid has gone negative.

If "stick" ringing is desired, a very high resistance is shunted around the bell in order to prevent interrupting V2's plate voltage. In series with the resistor is a switch which the operator opens when he wishes to stop the bell and acknowledge the call. See Figure 7.

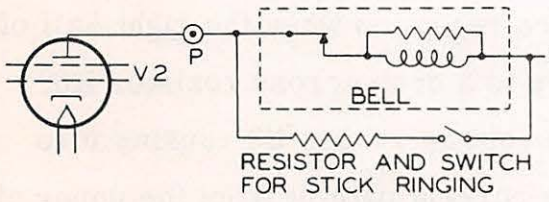


Figure 7. Stick ringing circuit.

3. Purpose of various components in the circuit, Figure 5.

(a). Condenser C1 prevents amplification of low-frequency pulses.

(b). Condenser C2 is a coupling condenser.

(c). Condenser C3 provides a means of controlling the grid voltage of the gas tube on reception of voice frequencies, and, through inherent timing of the charge and discharge, to discriminate between impulse transients and voice frequencies.

(d). Condenser C4, between V2's cathode and heater, is used to stabilize against noise voltages.

(e). Condenser C4, between V2's cathode and ground,acts as a by-pass to tie cathode to ground.

(f). Condenser C5 across the input transformer's secondary is used to subdue high frequency transients.

(g). Resistor R1 is the plate resistor for the Class A amplifier. This amplifier works on low plate voltage which limits the available amplification, thereby preventing passage of large voltage transients.

(h). Resistor R2 is a self-bias resistor for tube V1.

(j). Resistors R3 and R4 are voltage dividers to provide proper grid bias on the right-hand side of V1 to normally cut off this side when no voice signal is being received.

(k). Resistor R5 is the load resistor which has a voltage drop across it when a voice signal is being received. This voltage drop bucks the grid bias so as to allow plate current in the right-hand half of the tube to flow only during the positive half cycles of the applied signal voltage, thus operating the amplifier as a Class B.

(l). Resistors R6 and R7 provide, with condenser C3, a time-delay circuit when charging the condenser. The charging time is longer than the discharging time, since the discharge circuit is taken through resistor R7 and tube V1. The reason for maintaining this difference in the two times is to prevent V2 from firing unless a succession of waves, such as voice waves, are being received.

(m). Resistor R8 is a grid protective resistor.

(n). Resistor R9 is the sensitivity control potentiometer which changes the grid bias of the gas tube. Its position determines the signal strength required to fire the tube.

C. The Power Supply

The 24-volt local C.T.C. battery provides all the voltage requirements of the unit. When a transformer with a 12-volt secondary is available, also a power-transfer relay, the heaters of the two tubes can be operated on a-c. instead of d-c. The a-c. is applied across terminals NH and H12. A voltage regulator or ballast tube V3 (Amperite 6H-11) is provided to prevent undesirable changes in the supply voltage when operating on battery, tubes V1 and V2 being sensitive to such changes since they are operating on low plate voltage.

The approximate energy consumption is 15 watts when the heaters are across 24 volts and 7.5 watts when across 12 volts.

D. Installation

The two units are designed for installation in the end cap units of G-R-S C.T.C. machines. Mounting dimensions are shown in Figures 2 and 4.

E. Limitations

The calling unit will not find an application on lines where there is continual conversation. It will not operate satisfactorily on lines which have carrier frequencies below 10,000 cycles.

F. Summary

1. The voice-actuated calling unit is a monitor of lines over which occasional calls are received. There is no noise when there are no calls on the line.
2. It operates a bell or a light directly, without an auxiliary relay.
3. The bell can be made "stick" or "non-stick" in operation. The light is always "stick" and must be extinguished by a manual switch.
4. It operates on C.T.C. local office battery (24-volt). No inverters or other sources of power are required.
5. It can be used on lines which have other services such as coded d-c. C.T.C., coded carrier C.T.C., selectors, etc.

G. Ordering Information

Before specifying a voice-actuated calling unit for a particular application, it is advisable to consult our engineering department to make sure that the device is suitable for the application. Certain data will be required such as:

1. The type of line circuit.
2. Longest calling distance.
3. Services superimposed on the same circuit.
4. Whether bell or light is desired.

* * *

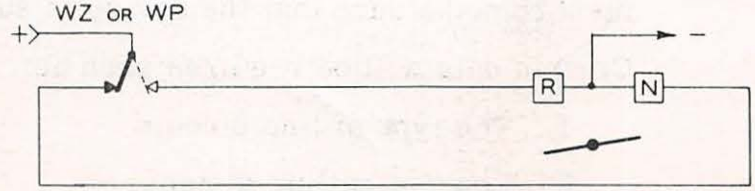
Movable Route Indicators and Biased Neutral Relays

As was noted in the November 1945 issue of the NEWS, "the biased neutral relay does not lend itself to circuits in which dependence was placed on the polar contact of neutral polar relay remaining in the last operated position with all energy removed from the relay." When energy is removed from a biased neutral relay, the armature releases and the front contacts open.

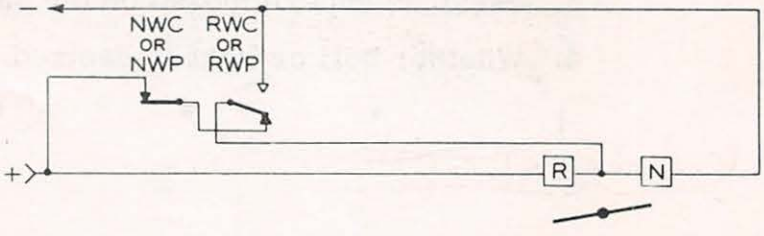
In the case of movable route indicator circuits such as are used with NX and the unit-lever types of electric interlocking, a circuit has been devised to provide a means of holding the route indicator in its normal or reverse position despite the fact that the biased neutral relay's contacts open on deenergization. This circuit is given below, together with the familiar circuit for neutral polar relays for comparison.

The means used for holding the route indicator in its last-operated position,after both biased neutral relays' contact open,is to have current continue to flow through both coils of the indicator. This current provides equal magnetic attraction in both coils of the indicator, but, since the armature is already attracted to one or the other pole face, it stays in that position until further operation of the biased neutral relays.

* * *



NEUTRAL POLAR RELAY'S CONTROL OF THE MOVABLE ROUTE INDICATOR



BIASED NEUTRAL RELAY'S CONTROL OF THE MOVABLE ROUTE INDICATOR

Type Letters Assigned to Control Machines

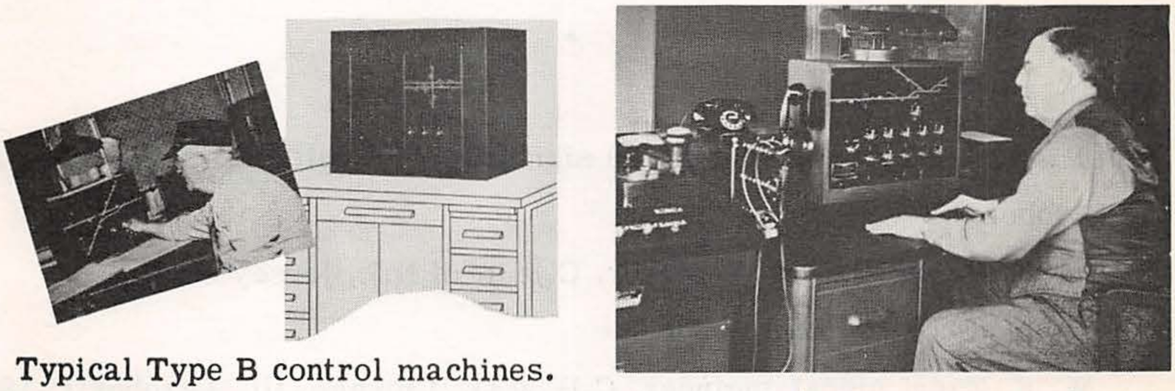
With reference to the brief note which appeared in last month's issue of G-R-S NEWS regarding the use of the term "desk type" for control machines, we are pleased to report that type letters have now been assigned our control machines to differentiate them.

All control machines that rest on a desk or table are to be referred to as Type B control machines.

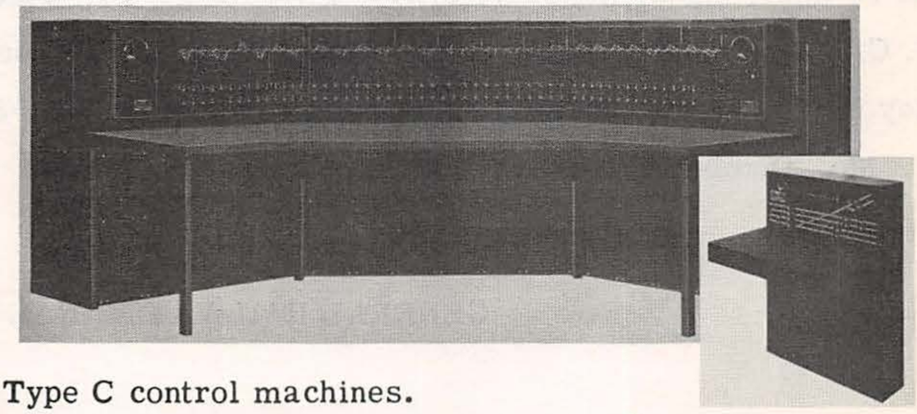
All control machines that stand on the floor are to be referred to as Type C control machines.

Whether the control machine is to be sectional or solid, with a shelf or without, with panels that jut out, etc., will have to be specified separately. The "type" designations are merely to avoid any misunderstanding which formerly resulted from the use of the term "desk type".

* * *



Typical Type B control machines.



Typical Type C control machines.

New Features for Type B Sectionalized Control Machines

The sectional control machine for installation on top of a desk is now being designed with a wider end cap (5 inches instead of 4) to accommodate an auxiliary panel. This panel, like the master unit panel on our C.T.C. machines, will carry maintainer call and other special switches, the register (also known as the cycle counter), meters, rheostats, and other devices, as required.

Another feature now available with the Type B sectional machine is the auxiliary track diagram which is mounted above the regular panels. This diagram gives such additional information as the car capacity of sidings, distance between sidings, normal direction of traffic, location of hand-thrown switches and crossovers, outlying switch locks, telephones, water columns, etc., which information does not appear on the regular panels.

* * *

October Birthdays

The following engineers in the signaling field celebrate their birthdays in October:

F. W. Bender, signal engineer, C.R.R. of N.J., Jersey City, N.J., October 15, 1882.

W. F. Zane, signal engineer, C.B. & Q., Chicago, Ill., October 1, 1882.

F. C. Stuart, signal engineer, E.J. & E., Joliet, Ill., October 20, 1876.

Roy E. Testerman, assistant signal engineer, St.L.-S.F., Springfield, Mo., October 27, 1901.

* * *

GENERAL RAILWAY SIGNAL COMPANY

G-R-S NEWS

August 1946

Assignment of Radio Frequencies for Railroad Service

In the December 1945 issue of G-R-S NEWS we published the proposed frequency assignments for railroads. Since that time changes have been made, and this summer a revised frequency assignment plan was forwarded to the Federal Communications Commission by A.A.R President J. J. Pelley.

The revised plan is included in this issue for your information.

* * *

I. FREQUENCIES IN THE 158.4 - 162 MEGACYCLE BAND

Frequencies in megacycles corresponding to the frequency numbers are as follows:

No.	MC	No.	MC	No.	MC	No.	MC
1	158.43	16	159.33	31	160.23	46	161.13
2	158.49	17	159.39	32	160.29	47	161.19
3	158.55	18	159.45	33	160.35	48	161.25
4	158.61	19	159.51	34	160.41	49	161.31
5	158.67	20	159.57	35	160.47	50	161.37
6	158.73	21	159.63	36	160.53	51	161.43
7	158.79	22	159.69	37	160.59	52	161.49
8	158.85	23	159.75	38	160.65	53	161.55
9	158.91	24	159.81	39	160.71	54	161.61
10	158.97	25	159.87	40	160.77	55	161.67
11	159.03	26	159.93	41	160.83	56	161.73
12	159.09	27	159.99	42	160.89	57	161.79
13	159.15	28	160.05	43	160.95	58	161.85
14	159.21	29	160.11	44	161.01	59	161.91
15	159.27	30	160.17	45	161.07	60	161.97

The frequency assignment plan given here was prepared by the Communications Section, A.A.R., from data furnished by the railroads. It includes assignments for end-to-end (EE), point-to-train (PT) and yard (Y) and terminal (T) radio communication.

A brief outline of each of these types of service is given in the paragraphs which follow.

A. End-to-End

In this type of service radio communication between the engine and caboose of trains, particularly long freight trains, and radio communication from one train to another, is contemplated. For this service both the engine and the caboose will normally be equipped with a transmitter and a receiver, adjusted for operation on the same frequency. The frequency assignment plan provides one frequency for each railroad system for use in this type of communication.

B. Point-to-Train

In making assignments for point-to-train radio communication it was contemplated that the frequency assigned in this plan for that service would be used at fixed points along the railroad right-of-way for communication with moving trains. One receiver for reception of signals from these stations will normally be located on the caboose of each train equipped for this service. Replies from the train to the fixed station would then be transmitted on its end-to-end radio transmitter, operating on the end-to-end frequency. This arrangement permits the conductor to hear communications directed to him from a wayside fixed station when the end-to-end circuit is in use. In order to facilitate this method of operation it is desirable that the end-to-end and point-to-train frequencies assigned any particular railroad be separated in frequency as much as possible.

It is possible to employ other operating procedures for point-to-train communication. For example, a train might be equipped with a dual-frequency transmitter, or two transmitters, and communications between the train and the wayside fixed station carried on entirely on the point-to-train frequency, or entirely on the end-to-end frequency.

One of the six point-to-train frequencies (Nos. 1, 12, 20, 24, 36 and 44) has been assigned to each railroad proposing to use end-to-end radio communication. Because of the very limited number of frequencies for this type of communication, it may be that use of the proposed channel will result in interference with a paralleling railroad at some part of an extensive railroad system. In such cases one of the other five frequencies may be requested for use in the area where interference occurs. The point-to-train frequency assigned each railroad, therefore, is the one which it appears can be used without interference or with minimum of interference.

Point-to-train frequencies have not been assigned for use at yard and terminal stations because of the limited number of such frequencies and the importance of keeping them as free of interference as possible.

C. Yards and Terminals

In preparing the frequency assignment plan it was contemplated that yard radio communication will consist of communications between a fixed radio station in the yard and yard locomotives within the yard area. It is possible that either one-way or two-way communication might be used. In the case of a two-way system, it is probable that transmissions of both the yard engine and the yard fixed station will be made on the same frequency. Where two yards of a railroad are in close proximity, or where, for example, an east and west hump or classification yard are in the same area, two frequencies are assigned, sufficiently separated in frequency so that both yards can carry on radio communication service without mutal interference. While it is recognized that under some conditions of operation it would be desirable that the frequencies assigned be sufficiently close together so as to facilitate a change from one to the other by push button operation, it was not always possible to select frequencies which would fulfill this requirement.

In terminal operation a radio service from a fixed station in a terminal area to switching engines working throughout the area is contemplated. In general a terminal fixed station, or multiple stations where necessary, will communicate over an area of not more than 35 miles in diameter.

Under F.C.C.'s Rules, Part 16, yard and terminal stations may be operated on frequencies in the 158.4-162 mc. band provided no interference is caused train radio stations.

II. TELEVISION BAND (44-50, 54-72, 76-82 and 186-216 megacycles)

Some frequency assignments for yards and terminals requested by railroads have been tentatively placed in the television bands. In these cases the exact frequency which can be used will not be known until the Federal Communications Commission has issued its national television channel assignment. In the meantime, however, authorizations for Experimental Class 2 Stations operating on these frequencies may be requested.

The A.A.R. frequency plan has been rearranged and condensed for your use on the following pages. The frequencies are shown down each page and the six districts are shown across two facing pages.

Under each district are shown the railroads which have been assigned each particular frequency and the particular use they can make of that frequency: EE being "End-to-End," PT "Point-to-Train," T "Terminals," and Y "Yards."

The six districts are:

1. New England, comprising Maine, Vermont, New Hampshire, Massachusetts, Connecticut and Rhode Island.
2. Northeast, comprising New York, Pennsylvania, New Jersey, Maryland, District of Columbia, Delaware, Ohio and Michigan (lower peninsula).
3. Pocahontas and Southern, comprising Virginia, West Virginia, Kentucky, Tennessee, Mississippi, Alabama, North Carolina, South Carolina, Georgia and Florida.
4. Northwest, comprising Wisconsin, Michigan (upper peninsula), Minnesota, North Dakota, South Dakota, Montana, Wyoming, Idaho, Oregon and Washington.
5. Central West, comprising Indiana, Illinois, Iowa, Missouri, Nebraska, Kansas, Colorado and Utah.
6. West and Southwest, comprising Arkansas, Louisiana, Oklahoma, Texas, New Mexico, Arizona, Nevada and California.

The television frequency assignments are listed starting on page 14. Finally, there follows an alphabetical list of railroads showing terminals and yards and the frequency numbers assigned to them, for the benefit of those of us who are interested in a particular railroad.

Freq.	New England				Northeast				Pocahontas & Southern			
	EE	PT	T	Y	EE	PT	T	Y	EE	PT	T	Y
No. 1 158.43						P&WVa WMd D&TSL LV D&M				GM&O G&F P&WVa WMd Virg. TA&G MP		
No. 2 158.49	CP(US)						NYC	NYC P&LE PM				
No. 3 158.55				CV	Read'g NYO&W C&I		B&LE P&WVa	B&LE	TC C&G		C&O	C&O
No. 4 158.61				Rutld	CRRy Wabash		BCr	BCr W&LE				
No. 5 158.67					AC&Y			PS&N P&LE WMd	SAL			WMd
No. 6 158.73			B&M				LV B&M	Pa-Rg LV				
No. 7 158.79							NYC	NYC P&LE Erie				G&F
No. 8 158.85					GTW		Erie	Erie DT&I			NC&SL	NC&SL N&PB
No. 9 158.91	CV							Read'g				BS ACL
No. 10 158.97	Bg&Ar				B&O			Wabash NYO&W DT&I	B&O			N&PB
No. 11 159.03											GM&O	GM&O
No. 12 159.09		B&M				Pa-Rg B&LE PS&N C&O PM Erie NJ&NY B&M Y&S				SLSF C&O Clinch CofG		
No. 13 159.15												
No. 14 159.21					LV		C&I		NS FEC			
No. 15 159.27				CV				B&O Read'g PM	NC&SL			

EE - End to End PT - Point to Train T - Terminal Y - Yard

Central West				Northwest				West & Southwest				Freq.
EE	PT	T	Y	EE	PT	T	Y	EE	PT	T	Y	
	C&EI CGW MP GM&O UP C&IM				GB&W LS&I CGW UP C&W		DW&P		GM&O MP SN UP McCld SDA&E			No. 1 158.43
IHB			IU CB&Q AT&SF				DSS&A DM&IR NP			CW&NC		No. 2 158.49
			M&SL CB&Q					T&P			P&SR	No. 3 158.55
Wabash			B&G Bamb				SP			SP		No. 4 158.61
MidVy								MidVy				No. 5 158.67
CMSPP		CB&Q		CMSPP			Soo				SDA&E FW&DC	No. 6 158.73
A&S D&RGW			NYC SL&SW	PdElec				D&RGW		AT&SF		No. 7 158.79
GTW										SP	SP	No. 8 158.85
KCS		MP		DM&IR				KCS		MP		No. 9 158.91
B&O			WP			PdElec				SLSW	WP	No. 10 158.97
			B&G GM&O								GM&O	No. 11 159.03
	PM C&O IU C&NW Alton AT&SF SLSF WCF&N UIC Bamb Erie CSPMO				C&NW NP CSPMO				SLSF AT&SF P&SR			No. 12 159.09
								CW&NC			T&P	No. 13 159.15
EJ&E MKT		C&EI						MKT				No. 14 159.21
B&G		D&RGW CMSPP	C&S D&RGW B&O									No. 15 159.27

Frequency Nos. 1 to 15

Freq.	New England				Northeast				Pocahontas & Southern			
	EE	PT	T	Y	EE	PT	T	Y	EE	PT	T	Y
No. 16 159.33							Erie	Erie			SAL C&G	SAL
No. 17 159.39								A&BB				Virg G&F
No. 18 159.45	B&A				NYC			Read'g	NYC		NP	
No. 19 159.51			Rutld					PS&N				Clinch
No. 20 159.57		MeC				NYS&W DT&I L&N NYO&W W&LE Y&N				IC L&N W&OD ACL SLSW		
No. 21 159.63								Read'g Union				
No. 22 159.69					WMd		CV	NYS&W GTW B&O LV P&LE NYC	WMd		SAL	SAL TA&G
No. 23 159.75				B&M				Pa-Rg				
No. 24 159.81		CV				NKP C&I Y&S Wabash AC&Y				SAL		
No. 25 159.87								Union				
No. 26 159.93					Sou		B&O D&M	NYS&W B&O	Sou			
No. 27 159.99				Bg&Ar	P&WVa		TTerm		P&WVa		Tenn Cop	
No. 28 160.05					Erie NJ&NY				N&PB		SLSF	
No. 29 160.11				B&M			PM	Pa-Rg B&M	GM&O		L&N	FEC L&N
No. 30 160.17					Union		NYC W&LE	NYC P&LE W&LE	TA&G		SAL	SAL NC&SL

EE - End to End PT - Point to Train T - Terminal Y - Yard

Central West				Northwest				West and Southwest				Freq.
EE	PT	T	Y	EE	PT	T	Y	EE	PT	T	Y	
CI&L M&SL			CRI&P Alton	M&SL			GN				CRI&P	No. 16 159.33
SP				SP				SP				No. 17 159.39
NYC		UP	AT&SF			CMSPP	CMSPP				AT&SF	No. 18 159.45
												No. 19 159.51
	L&N IC SLSW IHB MKT				DSS&A GN				SLSW IC L&N MKT			No. 20 159.57
			B&G Bamb			GB&W				WP	WP	No. 21 159.63
CB&Q C&S			NYC	CB&Q				FW&DC C&S				No. 22 159.69
			IU									No. 23 159.75
	NKP D&RGW Wabash CRI&P Soo CA&E				Soo CRI&P SP&S				CRI&P T&P NWP Sierra D&RGW			No. 24 159.81
		Alton										No. 25 159.87
Sou B&OCT			MKT			GN	GN				SN MKT	No. 26 159.93
UP				UP			M&SL	UP				No. 27 159.99
Erie		SLSF						SDA&E		SLSF	SP	No. 28 160.05
GM&O		L&N	C&S	DW&P CN(US)				GM&O		FW&DC		No. 29 160.11
IU CGW C&IM			CI&L	GB&W CGW			PdElec			KCS	T&P	No. 30 160.17

Frequency Nos. 16 to 30

Freq.	New England				Northeast				Pocahontas & Southern			
	EE	PT	T	Y	EE	PT	T	Y	EE	PT	T	Y
No. 31 160.23					D&TSL			Y&N				
No. 32 160.29			CV	CV			DL&W B&O	B&O DL&W	G&F			BS
No. 33 160.35											NC&SL	NC&SL
No. 34 160.41			B&A	B&A	C&O		NYC B&O	NYC P&LE	C&O MP			
No. 35 160.47											CofG	CofG Clinch
No. 36 160.53		Bg&Ar Rutld NYNH				Read'g NYNH B&O GTW DL&W Rutld				B&O NS TC C&G FEC		
No. 37 160.59							NJRCo					
No. 38 160.65					NYS&W D&H		NKP Read'g	NKP N&SS NYC D&M PM				NC&SL
No. 39 160.71								Y&N	Virg CofG			
No. 40 160.77					PRR LI				PRR			L&N
No. 41 160.83			NYNH	NYNH	Y&N		NYNH	NYNH			SAL	SAL
No. 42 160.89							NYC C&O	CNJ N&SS NYC	SLSW			C&O BS
No. 43 160.95								B&O			Tenn Cop	B&O
No. 44 161.01		B&A CP(US)				NYC CRRy CNJ				NYC NC&SL		
No. 45 161.07			NYNH	NYNH								

EE - End to End PT - Point to Train T - Terminal Y - Yard

Central West				Northwest				West and Southwest				Freq.
EE	PT	T	Y	EE	PT	T	Y	EE	PT	T	Y	
		CB&Q	CB&Q	LS&I								No. 31 160.23
C&EI		D&RGW CGW	D&RGW B&O MKT					McCld			MKT	No. 32 160.29
		B&G		NP							SP	No. 33 160.35
C&O MP		D&RGW	NYC					MP				No. 34 160.41
												No. 35 160.47
	B&O CI&L GTW CMSPP WP IT				CMSPP DM&IR PdElec				TE WP			No. 36 160.53
			UIC				Soo					No. 37 160.59
AT&SF			NKP					AT&SF		T&P		No. 38 160.65
CSPMO				CSPMO						SP		No. 39 160.71
PRR			B&G			UP	UP	SN				No. 40 160.77
			D&RGW CB&Q					P&SR			T&P	No. 41 160.83
C&NW SLSW Bamb			NYC	C&NW				SLSW				No. 42 160.89
							GN					No. 43 160.95
	NYC CB&Q M&SL KCS C&S SP B&G				CB&Q DW&P CN(US) M&SL SP				KCS SP CW&NC C&S			No. 44 161.01
		UP	CMSPP UP			UP	UP					No. 45 161.07

Freq.	New England				Northeast				Pocahontas & Southern			
	EE	PT	T	Y	EE	PT	T	Y	EE	PT	T	Y
No. 46 161.13							W&LE GTW	DL&W W&LE GTW	SLSF			
No. 47 161.19					Pa-Rg N&W		B&LE	B&LE	N&W		CofG	CofG
No. 48 161.25					NKP DetTer		NKP	CNJ				JTC
No. 49 161.31	NYNH MeC				NYNH Y&S			Read'g				
No. 50 161.37					DL&W		A&BB	B&O DT&I C&O	L&N		C&O CofG	C&O B&O CofG IC
No. 51 161.43				Bg&Ar								WMd
No. 52 161.49					PM		NKP	NKP CN&J				C&G
No. 53 161.55			NYNH	NYNH				Pa-Rg NYNH Read'g				NS SLSF
No. 54 161.61	B&M				B&M		NYC P&LE	NYC Read'g P&LE	CRI&P		NC&SL	NC&SL
No. 55 161.67							C&O	NYC	W&OD			
No. 56 161.73							N&SS	DL&W CNJ AC&Y	ACL			BS IC
No. 57 161.79			NYNH	NYNH	Mont'r Monon			Read'g NYNH C&O	Monon			
No. 58 161.85				Bg&Ar	DT&I		LV		IC			CofG
No. 59 161.91	Rutld				Rutld PS&N B&LE W&LE CNJ				Clinch		MP	Tenn Cent
No. 60 161.97					D&M		J&SC B&O GTW C&O	Read'g B&O PM GTW			N&PB GM&O Tenn Cop	B&O GM&O JTC NS SLSF

EE - End to End PT - Point to Train T - Terminal Y - Yard

Central West				Northwest				West and Southwest				Freq.
EE	PT	T	Y	EE	PT	T	Y	EE	PT	T	Y	
CR&I SLSF WCF&N			C&IM	MidCnt		NP		SLSF				No. 46 161.13
		UP C&NW	Wabash B&G C&NW			C&NW	DSS&A SP&S				SP	No. 47 161.19
NKP		MP	CB&Q Alton							MP	KCS	No. 48 161.25
		UP				GB&W						No. 49 161.31
L&N Soo		MKT	KCS B&G Bamb IC	Soo			GN	L&N		MKT	AT&SF IC	No. 50 161.37
			CMSPP CB&Q				CMSPP				SP	No. 51 161.43
PM IT		SL&SW C&S D&RGW	C&S D&RGW					TE			SLSW	No. 52 161.49
UIC											SP	No. 53 161.55
CRI&P			C&EI B&G	CRI&P SP&S			DM&IR	CRI&P		MP MKT		No. 54 161.61
C&W				C&W								No. 55 161.67
Alton		AT&SF	AT&SF				GB&W				AT&SF	No. 56 161.73
WP				GN				WP		MKT		No. 57 161.79
IC		CB&Q	CB&Q UP				CB&Q	IC				No. 58 161.85
		MP						Sierra		MP		No. 59 161.91
ChiBelt TRRA		NKP C&IM CGW UP B&G	NKP GTW SLSF UP C&W	DSS&A D&N		Soo UP	CRI&P Soo NP	NWP		LS SP SLSF UP	CRI&P UP SLSF	No. 60 161.97

Provision for the following stations may be made on Television channels:

1. In New York City Area		Frequencies
B&O	- T, N. Y. Hbr. Tugs	1
CNJ	- Y, Brills Yard, N. J.	2
	- Y, Jersey City, N. J.	2
	- T, Jersey City, N. J.	2
	- T, N. Y. Hbr. Tugs	1
DL&W	- T, Hoboken, N. J.	1
	- Y, Hoboken, N. J.	1
	- T, N. Y. Hbr. Tugs	1
Erie	- T, Jersey City, N. J.	1
	- T, N. Y. Hbr. Tugs	1
LV	- T, Jersey City, N. J.	1
NYC	- T, N. Y. Hbr. Tugs	1
Reading	- T, N. Y. Hbr. Tugs	1
2. In Pittsburgh Area		
NYC	- T, McKees Rocks	1
P&LE (NYC)	- Y, Port Vue	1
	Glassport	1
	Becks Run	1
	Gardner Ave.	1
	Montour Jc.	1
Union	- Y, Pittsburgh	4
3. In Toledo Area		
B&O	- Y, Toledo	2
C&O	- T, Toledo	1
NYC	- T, Toledo	1
W&LE	- T, Toledo	1
4. In Youngstown Area		
Youngstown & Northern	- Y, Youngstown	1
5. In Detroit Area		
DT&I	- T, Dearborn-Flatrock	1

6. In Hammond Area

		Frequencies
CI&L	- Y, Hammond	1
EJ&E	- T, E. Joliet	1
	- T, Gary	1
Erie	- T, Hammond	2

7. In Duluth Area

CStPM&O	- T, Duluth, Superior	1
DW&P	- T, Duluth	1
Grt. Nor.	- Y, Superior	1
MStP&SSM	- T, Superior	1
Nor. Pac.	- T, Duluth	1

8. In Minneapolis Area

CB&Q	- T, Minn. - St. Paul	1
CGW	- T, Minn. - St. Paul	1
CMStP&P	- T, Minn. - St. Paul	1
CStPM&O	- T, Minneapolis	1
	- T, St. Paul	1
Grt. Nor.	- T, Minn. - St. Paul	3
MStP&SSM	- T, Minn. - St. Paul	1
NP	- T, Minneapolis	1
	- T, St. Paul	1

9. In Omaha Area

UP	- T, Council Bluffs	1

10. In Kansas City Area

AT&SF	- T, Kansas City	1
Alton	- T, Kansas City	1
CGW	- T, Kansas City	1
CMStP&P	- T, Kansas City	1
KCS	- T, Kansas City	1
MKT	- T, Kansas City	1
MP	- T, Kansas City	1
StLSF	- T, Kansas City	1
UP	- T, Kansas City	2

11. In New Orleans Area

Public Belt RR. Comm.	- Y, New Orleans	5

12. In Chicago Area		Frequencies
AT&SF	Terminal	1
Alton	"	2
BRC of C	"	1
B&O	"	1
C&EI	"	1
C&NW	"	1
C&WI	"	2
CB&Q	"	1
CGW	"	1
CMStP&P	"	2
CR&I	"	1
EJ&E	"	1
Erie	"	1
GTW	"	1
IHB	"	1
MStP&SSM	"	1
NYC	"	1
NYC&StL (NKP)	"	1
PM	"	1
Wabash	"	1
C&EI	Chicago Heights	1
AT&SF	Yard, Chicago	1
Alton	" Harrison St.	1
	" Brighton Park	1
	" Glenn	1
BRC of C	" Chicago	2
B&O	" "	3
C&EI	" "	1
	" Chicago Heights	1
C&NW	" Chicago	4
CB&Q	" "	1
CRI&P	" "	1
GTW	" "	1
IC	" Hawthorne	1
	" Markham	2
IHB	" Blue Island	2
	" Gibson	2
MStP&SSM	" Chicago	1
NYC	" Englewood	1
NYC&StL (NKP)	" Chicago	1
PM	" "	1
Wabash	" "	1

13. In St. Louis Area

		Frequencies
Alton	- T, Brooklyn	1
	- Y, Cone	1
	- Y, Middle	1
	- T, St. Louis - E. St. L.	1
	- T, Venice	1
	- Y, Venice	1
A&S	- Y, E. St. Louis	2
	- T, St. Louis	1
B&O	- Y, St. Louis	4
C&EI	- T, St. Louis	1
	- Y, St. Louis	1
CB&Q	- T, St. Louis	1
	- Y, St. Louis	1
GM&O	- T, St. Louis	1
	- Y, St. Louis	2
IC	- Y, E. St. Louis	1
MKT	- T, St. Louis	1
	- Y, St. Louis (Baden)	1
MP	- T, St. Louis	1
	- Y, St. Louis	2
NYC	- Y, Brooklyn	1
NYC&StL (NKP)	- T, Madison	1
StLSF	- T, St. Louis	1
	- Y, St. Louis	1
StLSW	- Y, St. Louis	1
TRRA	- Y, E. St. Louis	6
	- T, St. Louis (Carrie)	1
Wabash	- Y, St. Louis	1

14. In Ft. Worth Area

FW&DC	- T, Ft. Worth	1
T&P	- T, Ft. Worth	1

The following is a list of yards and terminals with their assigned frequency numbers:

AKRON & BARBERTON BELT

Akron	-Y- (17)
Akron	-T- (50)

AKRON, CANTON & YOUNGSTOWN

Cary - Brittain	-Y- (56)

ALTON

Kansas City (12th St.)	-Y- (48)
Kansas City (Lydia Ave.)	-Y- (52)
Springfield	-Y- (16)
Springfield	-T- (25)

A.T.&S.F.

Albuquerque	-Y- (56)
Amarillo	-Y- (50)
Arkansas City	-Y- (18)
Ash Fork	-Y- (56)
Bakersfield	-Y- (50)
Barstow	-Y- (50)
Beaumont	-Y- (56)
Belen Jc.	-Y- (56)
Brownwood	-Y- (56)
Chanute	-Y- (18)
Chillicothe	-Y- (2)
Cleburne	-Y- (56)
Clovis	-Y- (56)
Dallas	-Y- (50)
Denver	-Y- (56)
Dodge City	-Y- (18)
El Paso	-Y- (50)
Emporia Jc.	-Y- (18)
Ft. Madison	-Y- (2)
Ft. Worth	-Y- (50)
Fresno	-Y- (50)
Gainesville	-Y- (56)

A.T.&S.F. (continued)

Gallup	-Y- (56)
Galveston	-Y- (56)
Houston	-Y- (50)
Hutchinson	-Y- (18)
Kansas City	-Y- (18)
La Junta	-Y- (56)
Las Vegas	-Y- (56)
Los Angeles	-T- (7)
Los Angeles	-Y- (50)
Marceline	-Y- (2)
Needles	-Y- (50)
Newton	-Y- (18)
Okla. C. Shawnee	-Y- (18)
Phoenix	-Y- (56)
Pueblo	-T- (56)
Purcell	-Y- (18)
San Bernardino	-Y- (50)
San Diego	-Y- (50)
San Francisco	-Y- (50)
S.F. - Oakland	-T- (7)
Seligman	-Y- (56)
Shawnee	-Y- (18)
Shattuck Jc.	-Y- (18)
Silsbee	-Y- (56)
Slaton Jc.	-Y- (56)
Somerville	-Y- (56)
Stockton	-Y- (50)
Sweetwater	-Y- (56)
Temple	-Y- (56)
Topeka	-Y- (18)
Tulsa	-Y- (18)
Vaughn	-Y- (56)
Waynoka	-Y- (18)
Wellington	-Y- (18)
Wichita	-Y- (18)
Winslow	-Y- (56)

ATLANTIC COAST LINE

Charleston	-Y-	(9)
Fairfield Jc.	-Y-	(56)
Florence	-Y-	(9)
Jacksonville	-Y-	(9)
Montgomery	-Y-	(9)
Richmond	-Y-	(9)
Savannah	-Y-	(9)
Tampa	-Y-	(9)
Waycross	-Y-	(9)
Wilmington	-Y-	(9)

BALTIMORE & OHIO

Akron	-Y-	(26)
Akron	-T-	(32)
Baltimore	-Y-	(15)
Baltimore	-T-	(26)
Baltimore	-Y-	(26)
Baltimore	-Y-	(32)
Baltimore (Tugs)	-T-	(34)
Baltimore	-Y-	(43)
Baltimore	-Y-	(50)
Baltimore	-Y-	(60)
Brunswick	-Y-	(15)
Brunswick	-Y-	(32)
Brunswick	-Y-	(50)
Buffalo	-Y-	(26)
Buffalo	-Y-	(60)
Chillicothe	-Y-	(26)
Chillicothe	-Y-	(50)
Chillicothe	-Y-	(60)
Cincinnati	-Y-	(15)
Cincinnati	-Y-	(22)
Cincinnati	-Y-	(32)
Cincinnati	-Y-	(50)
Cincinnati	-T-	(60)
Cleveland	-T-	(26)
Cleveland	-Y-	(50)
Cumberland	-Y-	(15)
Cumberland	-Y-	(32)
Cumberland	-Y-	(43)
Cumberland	-Y-	(60)

B. & O. (continued)

Dubois	-Y-	(15)
Dubois	-Y-	(32)
Grafton	-Y-	(43)
Grafton	-Y-	(50)
Grafton	-Y-	(60)
Indianapolis	-Y-	(15)
Indianapolis	-Y-	(32)
Lorain	-Y-	(60)
Mosel	-T-	(60)
Newark	-Y-	(26)
Newark	-Y-	(50)
Newcastle	-Y-	(15)
Newcastle	-Y-	(32)
Newcastle	-Y-	(60)
Parkersburg	-Y-	(43)
Parkersburg	-Y-	(60)
Philadelphia	-Y-	(15)
Philadelphia	-T-	(26)
Philadelphia	-Y-	(32)
Philadelphia (Tugs)	-T-	(34)
Philadelphia	-Y-	(43)
Pittsburgh	-Y-	(15)
Pittsburgh	-Y-	(32)
Pittsburgh	-Y-	(50)
Pittsburgh	-Y-	(60)
Punxsutawney	-Y-	(15)
Punxsutawney	-Y-	(32)
Rochester	-Y-	(26)
Rochester	-Y-	(32)
Wheeling	-Y-	(43)
Wheeling	-Y-	(60)
Willard	-Y-	(26)
Willard	-Y-	(50)
Willard	-Y-	(60)

BAMBERGER

Clearfield	-Y-	(4)
Clearfield	-Y-	(50)
Ogden	-Y-	(21)
Salt Lake City	-Y-	(4)
Salt Lake City	-Y-	(21)

BANGOR & AROOSTOOK

Caribou	-Y- (58)
Derby	-Y- (58)
Ft. Fairfield	-Y- (51)
Ft. Kent	-Y- (58)
Houlton	-Y- (58)
Millinocket	-Y- (27)
Millinocket	-Y- (51)
Millinocket	-Y- (58)
No. Maine Jc.	-Y- (27)
No. Maine Jc.	-Y- (51)
No. Maine Jc.	-Y- (58)
Oakfield	-Y- (51)
Phair	-Y- (58)
Presque Is.	-Y- (27)
Searsport	-Y- (58)
So. Le Grange	-Y- (51)
Van Buren	-Y- (58)
W. Seboois	-Y- (51)

BESSEMER & LAKE ERIE

Branchton	-Y- (47)
Butler	-Y- (47)
Conneaut	-Y- (3)
Cranesville	-T- (3)
Greenville	-T- (47)
Russellton Area	-T- (3)

BINGHAM & GARFIELD

Bingham	-Y- (4)
Bingham	-Y- (21)
Bingham	-T- (60)
Garfield	-Y- (40)
Garfield	-Y- (47)
Garfield	-Y- (54)
Magna	-T- (33)
Magna	-Y- (50)
Yampa	-Y- (11)

BIRMINGHAM SOUTHERN

Ensley	-Y- (9)
Ensley	-Y- (32)
Fairfield Jc.	-Y- (42)
Fairfield Jc.	-Y- (56)

BOSTON & MAINE

Boston	-T- (6)
Boston	-Y- (23)
Boston	-Y- (29)
E. Deerfield	-T- (6)
E. Deerfield	-Y- (29)
Fitchburg	-T- (6)
Fitchburg	-Y- (29)
Mechanicville	-T- (6)
Mechanicville	-Y- (29)
Portland	-T- (6)
Portland	-Y- (29)

BUFFALO CREEK

Buffalo	-T- (4)

CAL. WESTN. RR. & NAV. CO.

Ft. Bragg	-T- (2)
Willits	-T- (2)

CAMBRIA & INDIANA

Colver	-T- (14)

CENTRAL OF GEORGIA

Albany	-Y- (50)
Americus	-Y- (50)
Atlanta	-T- (47)
Atlanta	-Y- (58)
Augusta	-Y- (50)
Birmingham	-T- (35)

CENTRAL OF GEORGIA (continued)

Chattanooga	-Y- (58)
Columbus	-T- (50)
Columbus	-Y- (58)
E. Thomas	-T- (35)
Griffin	-Y- (50)
Leeds	-T- (35)
Macon	-T- (30)
Macon	-T- (50)
Macon	-Y- (58)
Margaret	-T- (35)
Millen	-Y- (50)
Savannah	-T- (47)
Savannah	-Y- (35)
Smithville	-Y- (58)

C.R.R. OF N.J.

Allentown	-Y- (48)
Allentown	-Y- (42)
Ashley	-Y- (42)
Ashley	-Y- (48)
Elizabethport	-Y- (42)
Elizabethport	-Y- (48)
Mauch Chunk	-Y- (42)
Mauch Chunk	-Y- (48)
Penobscot	-Y- (52)
Penobscot	-Y- (56)

CENTRAL OF VERMONT

Brattleboro	-Y- (3)
Brattleboro	-T- (32)
New London	-Y- (15)
New London	-T- (32)
St. Albans	-Y- (15)
St. Albans	-T- (32)
White River Jc.	-Y- (32)

CHESAPEAKE & OHIO

Ashland	-Y- (3)
Ashland	-Y- (42)
Ashland	-Y- (50)
Cincinnati	-T- (42)
Clifton Forge	-Y- (42)
Clifton Forge	-Y- (50)
Louisville	-T- (3)
Mosel	-T- (60)
Newport News	-T- (3)
Newport News	-Y- (42)
Newport News	-Y- (50)
Richmond	-T- (50)
Stevens	-Y- (3)
Stevens	-Y- (42)
Toledo	-Y- (50)
Toledo	-Y- (57)
Washington	-T- (55)

CHICAGO & EASTERN ILLINOIS

Danville	-Y- (14)
Danville	-T- (54)
Evansville	-Y- (14)
Evansville	-T- (54)
Grove	-T- (14)
Salem	-Y- (14)
Salem	-T- (54)
Terre Haute	-Y- (14)
Terre Haute	-T- (54)
Villa Grove	-Y- (14)
Villa Grove	-T- (54)

CHICAGO & ILLINOIS MIDLAND

Havana	-Y- (46)
Pekin	-T- (60)
Petersburg	-Y- (46)
Springfield	-Y- (46)
Taylorville	-Y- (46)

C. & N. W.

Clinton	-Y- (47)
Milwaukee	-T- (47)
Omaha	-T- (47)
Sioux City	-T- (47)

C. B. & Q.

Alliance	-Y- (58)
Aurora	-Y- (31)
Aurora	-T- (58)
Beardstown	-Y- (31)
Brookfield	-Y- (58)
Burlington	-Y- (2)
Burlington	-T- (31)
Casper	-Y- (58)
Centralia	-Y- (31)
Creston	-Y- (2)
Denver	-T- (31)
Denver	-Y- (48)
Galesburg	-Y- (2)
Galesburg	-Y- (31)
Galesburg	-Y- (51)
Galesburg	-T- (58)
Hannibal	-Y- (58)
Kansas City	-Y- (41)
Lincoln	-T- (6)
Lincoln	-Y- (51)
Lincoln	-Y- (58)
McCook	-Y- (58)
No. La. Crosse	-Y- (58)
Omaha	-Y- (2)
Omaha	-Y- (3)
Omaha	-T- (51)
Ottumwa	-T- (31)
Ottumwa	-Y- (2)
Quincy	-Y- (31)
Savanna	-Y- (31)
St. Joseph	-T- (6)
St. Joseph	-Y- (58)
St. Paul	-Y- (58)
Sheridan	-Y- (58)

CHICAGO GREAT WESTERN

Des Moines	-T- (60)
Oelwein	-T- (60)
Omaha	-T- (32)

C. I. & L.

Bloomington	-Y- (30)
Lafayette	-Y- (30)

C. M. ST. P. & P.

Aberdeen	-Y- (51)
Black Rv. Jc.	-Y- (51)
Butte	-Y- (51)
Council Bluffs	-T- (15)
Des Moines	-Y- (45)
Des Moines	-Y- (51)
Dubuque	-Y- (51)
La Crosse	-Y- (18)
Madison	-Y- (18)
Miles City	-Y- (51)
Milton Jc.	-Y- (18)
Milwaukee	-T- (18)
Ottumwa Jc.	-Y- (51)
Perry	-Y- (51)
Portage	-Y- (18)
Sioux City	-Y- (51)
Tacoma	-Y- (51)
Terre Haute	-Y- (51)

C. R. I. & P.

El Reno	-Y- (16)
Ft. Worth	-Y- (60)
Herington	-Y- (16)
Kansas City	-Y- (16)
Rock Island	-Y- (16)
W. St. Paul	-Y- (60)

CLINCHFIELD

Erwin	-Y- (19)
Erwin	-Y- (35)

COLORADO & SOUTHERN

Denver	-Y- (15)
Denver	-T- (52)
Pueblo	-Y- (29)
Pueblo	-Y- (52)
Trinidad	-Y- (29)
Trinidad	-T- (52)

COLORADO & WYOMING

Pueblo	-Y- (60)

COLUMBUS & GREENVILLE

Columbus	-T- (16)
Columbus	-Y- (52)
Greenville	-T- (16)
Greenville	-Y- (52)
Greenwood	-Y- (52)

CUYAHOGA VALLEY

Cleveland	-T- (22)

D. L. & W.

Binghamton	-Y- (46)
Buffalo	-T- (32)
Buffalo	-Y- (46)
Buffalo	-Y- (56)
Elmira	-Y- (46)
Hoboken	-Y- (46)
Kingston	-Y- (46)
Lake Hopatcong	-Y- (46)
Scranton	-Y- (46)
Scranton	-T- (18)
Scranton	-Y- (32)
Scranton	-Y- (56)
Secaucus	-Y- (32)

D. & R. G. W.

Alamosa	-Y- (52)
Denver	-T- (34)
Denver	-Y- (41)

D. & R. G. W. (continued)

Durango	-Y- (52)
Grand Jc.	-Y- (52)
Helper	-Y- (52)
Marysvale	-Y- (52)
Minturn	-Y- (52)
Ogden	-Y- (15)
Ogden	-T- (32)
Pueblo	-T- (15)
Pueblo	-Y- (41)
Salida	-Y- (52)
Salt Lake City	-Y- (32)
Salt Lake City	-T- (52)

DETROIT & MACKINAC

Alpena	-T- (26)
Alpena	-Y- (38)
Bay City	-T- (26)
Bay City	-Y- (38)
Cheboygan	-T- (26)
Tawas	-T- (26)

DETROIT, TOLEDO & IRONTON

Ecorse	-Y- (50)
Flatrock	-Y- (10)
Flatrock	-Y- (50)
Lima	-Y- (8)
Springfield	-Y- (8)
Wyandotte	-Y- (10)

D. M. & I. R.

Hibbing	-Y- (2)
Proctor	-Y- (54)
Steelton	-Y- (54)
Two Harbors	-Y- (2)
Virginia	-Y- (2)

D. S. S. & A.

Marquette	-Y- (2)
S. Ste. Marie	-Y- (2)
St. Ignace	-Y- (2)
Superior	-Y- (47)

DULUTH, WINNIPEG & PACIFIC

Duluth	-Y- (3)

ERIE

Avoca	-Y- (16)
Buffalo	-T- (8)
Buffalo	-T- (16)
Cleveland	-T- (16)
Croxton	-Y- (8)
Croxton	-Y- (16)
Ferrona	-Y- (16)
Hornell	-Y- (8)
Hornell	-Y- (16)
Kent	-Y- (8)
Kent	-Y- (16)
Marion	-Y- (8)
Marion	-Y- (16)
Meadville	-Y- (16)
Paterson	-Y- (8)
Port Jervis	-Y- (8)
Youngstown	-Y- (8)
Youngstown	-Y- (16)

FLORIDA EAST COAST

Ft. Pierce	-Y- (29)
Jacksonville	-Y- (29)
Miami	-Y- (29)
New Smyrna Bch.	-Y- (29)
W. Palm Bch.	-Y- (29)

FORT WORTH & DENVER CITY

Amarillo	-Y- (6)
Amarillo	-T- (29)
Childress	-Y- (6)
Childress	-T- (29)
Ft. Worth	-Y- (6)
Wichita Falls	-Y- (6)
Wichita Falls	-T- (29)

GEORGIA & FLORIDA

Augusta	-Y- (7)
Augusta	-Y- (17)

GRAND TRUNK WESTERN

Battle Creek	-Y- (46)
Belsay	-Y- (60)
Detroit	-Y- (22)
Detroit	-Y- (46)
Detroit	-T- (60)
Durand	-Y- (46)
Muskegon	-T- (46)
Muskegon	-Y- (60)
Olivers	-Y- (60)
Pontiac	-Y- (46)
Port Huron	-T- (46)
Port Huron	-Y- (60)

GREAT NORTHERN

Allouez	-Y- (16)
Allouez	-Y- (26)
Everett	-Y- (50)
Grand Forks	-Y- (43)
Great Falls	-Y- (43)
Havre	-Y- (43)
Hillman Jc.	-T- (26)
Hillyard	-Y- (50)
Minot	-Y- (43)
Seattle	-Y- (16)
Seattle	-Y- (50)
White Fish	-Y- (43)
Willmar	-Y- (26)

GREEN BAY & WESTERN

Green Bay	-T- (21)
Green Bay	-T- (49)
Green Bay	-Y- (56)
Kewaunee	-Y- (56)
Sturgeon Bay	-Y- (56)
Winona	-Y- (56)
Wis. Rapids	-Y- (56)

GULF, MOBILE & OHIO

Artesia	-Y- (11)
Bogalusa	-Y- (11)
Corinth	-Y- (11)
Jackson	-Y- (11)
Jackson	-T- (11)
Laurel	-Y- (11)
Louisville	-Y- (11)
Meridian	-Y- (11)
Mobile	-T- (11)
Montgomery	-T- (60)
New Albany	-Y- (60)
Tamms	-Y- (11)
Tuscaloosa	-T- (11)
Union	-Y- (11)

ILLINOIS CENTRAL

Clinton	-Y- (50)
Fulton	-Y- (50)
Kenner Jc.	-Y- (50)
Nonconnah	-Y- (50)
Nonconnah	-Y- (56)

INDIANAPOLIS UNION

Indianapolis	-Y- (2)
Indianapolis	-Y- (23)

JACKSONVILLE TERMINAL CO.

Jacksonville	-Y- (48)
Jacksonville	-Y- (60)

JOHNSTOWN & STONY CREEK

Johnstown	-T- (60)

KANSAS CITY SOUTHERN

Kansas City	-Y- (50)
Shreveport	-T- (30)
Shreveport	-Y- (48)

LEHIGH VALLEY

Buffalo	-Y- (6)
Buffalo	-Y- (22)
Buffalo	-T- (58)
Coxton	-Y- (6)
Manchester	-Y- (6)
Manchester	-Y- (22)
Oak Island Jc.	-Y- (6)
Oak Island Jc.	-Y- (22)
Packerton	-Y- (6)
Packerton	-Y- (22)
Sayre	-T- (6)

LOUISIANA SOUTHERN

New Orleans	-T- (60)

LOUISVILLE & NASHVILLE

Birmingham	-T- (29)
Corbin	-Y- (29)
Evansville	-T- (29)
Knoxville	-T- (29)
Louisville	-T- (29)
Nashville	-Y- (29)
Nashville	-Y- (40)

MINNEAPOLIS & ST. LOUIS

Marshalltown	-Y- (3)
Minneapolis	-Y- (27)
Oskaloosa	-Y- (3)
Peoria	-Y- (3)

M. ST. P. & S. S. M. (SOO)

Chippewa Falls	-Y- (37)
Deerwood	-T- (60)
Fond du Lac	-Y- (37)
Glenwood	-Y- (60)
Lady Smith	-Y- (37)
Marshfield	-Y- (37)
Menasha	-Y- (37)
Stevens Pt.	-Y- (37)
Superior	-Y- (6)
Three River Falls	-Y- (37)

MISSOURI-KANSAS-TEXAS

Boonville	-Y- (26)
Boonville	-T- (50)
Dallas	-Y- (26)
Dallas	-T- (57)
Denison	-Y- (26)
Denison	-Y- (32)
Denison	-T- (50)
Ft. Worth	-Y- (26)
Ft. Worth	-T- (57)
Houston	-Y- (26)
Houston	-T- (50)
McAlester	-Y- (26)
McAlester	-T- (50)
Muskogee	-Y- (26)
Muskogee	-T- (50)
Oklahoma City	-Y- (26)
Oklahoma City	-T- (50)
Parsons	-Y- (26)
Parsons	-Y- (32)
San Antonio	-Y- (26)
San Antonio	-T- (57)
Smithville	-Y- (26)
Smithville	-T- (50)
Waco	-Y- (26)
Waco	-T- (50)
Wichita Falls	-Y- (26)
Wichita Falls	-T- (50)

MISSOURI PACIFIC

Alexandria	-T- (59)
Anchorage	-T- (48)
Atchison	-T- (48)
Austin	-T- (48)
Baton Rouge	-T- (48)
Beaumont	-T- (48)
Brownsville	-T- (48)
Bush	-T- (48)
Coffeyville	-T- (48)
De Quincy	-T- (59)
Ft. Smith	-T- (48)
Ft. Worth	-T- (9)

MISSOURI PACIFIC (continued)

Galveston	-T- (48)
Harlingen	-T- (48)
Hoisington	-T- (48)
Houston	-T- (59)
Jefferson City	-T- (48)
Kingsville	-T- (48)
Lake Charles	-T- (59)
Laredo	-T- (48)
Little Rock	-T- (59)
Longview	-T- (48)
Mart	-T- (48)
McGhee	-T- (59)
Memphis	-T- (18)
Monroe	-T- (48)
Natchez	-T- (59)
Nevada	-T- (48)
New Orleans	-T- (54)
Omaha	-T- (9)
Osawatomie	-T- (48)
Palestine	-T- (48)
Poplar Bluff	-T- (59)
Pueblo	-T- (47)
St. Joseph	-T- (48)
San Antonio	-T- (48)
Taylor	-T- (48)
Texarkana	-T- (59)
Wichita	-T- (9)

N. C. & ST. L.

Atlanta	-Y- (8)
Atlanta	-Y- (33)
Atlanta	-T- (54)
Bridgeport	-Y- (8)
Bridgeport	-Y- (54)
Bruceton	-Y- (8)
Bruceton	-Y- (54)
Cartersville	-Y- (33)
Cartersville	-Y- (54)
Chattanooga	-T- (8)
Chattanooga	-Y- (33)
Chattanooga	-Y- (54)

N. C. & ST. L. (continued)

Cowan	-Y- (8)
Cowan	-Y- (54)
Decherd	-Y- (8)
Decherd	-Y- (54)
Dickson	-Y- (8)
Dickson	-Y- (54)
Jackson	-Y- (33)
Jackson	-Y- (54)
Marietta	-Y- (33)
Marietta	-Y- (54)
Martin	-Y- (8)
Martin	-Y- (54)
McKenzie	-Y- (8)
McKenzie	-Y- (54)
Memphis	-T- (8)
Memphis	-Y- (30)
Memphis	-Y- (38)
Murfreesboro	-Y- (8)
Murfreesboro	-Y- (54)
Nashville	-T- (8)
Nashville	-Y- (33)
Nashville	-Y- (54)
Paducah	-Y- (8)
Paducah	-T- (33)
Paducah	-Y- (54)
Tullahoma	-Y- (8)
Tullahoma	-Y- (54)

NEWBURGH & SO. SHORE

Cleveland	-T- (56)
Marceline	-Y- (38)
Seneca	-Y- (42)

NEW YORK CENTRAL

Airline	-Y- (42)
Airline	-Y- (55)
Albany	-T- (30)
Aliquippa	-Y- (54)
Ashtabula	-T- (7)
Battle Creek	-T- (54)
Bay City	-T- (34)
Bellefontaine	-Y- (2)
Bellefontaine	-Y- (7)

N. Y. C. (continued)

Boston	-T- (34)
Buffalo, No.	-T- (54)
Buffalo, So.	-T- (42)
Cleveland	-T- (2)
Collinwood	-Y- (7)
Columbus	-T- (7)
Corning	-Y- (7)
Danville	-Y- (22)
Detroit	-T- (42)
Dewitt	-Y- (7)
Dewitt	-Y- (54)
Elkhart	-Y- (7)
Erie	-T- (7)
Gardenville	-Y- (30)
Gardenville	-Y- (34)
Grand Rapids	-Y- (7)
Grand Rapids	-T- (54)
Harrisburg	-Y- (7)
Indianapolis	-Y- (7)
Indianapolis	-Y- (34)
Indianapolis	-Y- (54)
Jackson	-T- (7)
Jackson	-Y- (54)
Kalamazoo	-T- (54)
Matton	-Y- (7)
McKees Rocks	-Y- (38)
McKees Rocks	-Y- (54)
Mott Haven	-T- (30)
Newberry Jc.	-Y- (30)
Niles	-Y- (2)
Niles	-Y- (7)
Niles	-Y- (54)
North Yards	-Y- (22)
North Yards	-Y- (55)
Pittsburgh	-T- (42)
Riverside	-Y- (54)
Rochester	-T- (54)
Rockport	-Y- (7)
Saginaw	-Y- (7)
Saginaw	-T- (34)
Selkirk	-Y- (2)
Selkirk	-Y- (7)
Selkirk	-Y- (54)

N. Y. C. (continued)

Sharon	-Y- (2)
Sharon	-Y- (7)
Sharon	-Y- (17)
Sharon Yd.	-Y- (30)
Springfield	-T- (34)
Stanley	-Y- (2)
Stanley	-Y- (7)
Sus. Br. Niag. Falls	-T- (7)
Syracuse	-T- (30)
Terre Haute	-Y- (22)
Tonawanda	-T- (2)
Tugs, N.Y. Harbor	-T- (7)
Utica	-T- (30)
Watertown	-Y- (2)
Weehawken	-Y- (55)
Wenona	-Y- (54)
W. Yard	-Y- (34)
W. Yard	-Y- (38)
Westside	-T- (34)
Worcester	-Y- (34)
Youngstown	-T- (2)

N. Y. C. & ST. L. (NICKEL PLATE)

Bellevue	-Y- (38)
Buffalo	-T- (38)
Buffalo	-Y- (52)
Charlestown	-Y- (38)
Cleveland	-T- (52)
Conneaut	-Y- (38)
Conneaut	-T- (52)
Erie	-Y- (38)
Ft. Wayne	-Y- (38)
Ft. Wayne	-T- (60)
Fostoria	-Y- (38)
Fostoria	-T- (52)
Frankfort	-Y- (60)
Indianapolis	-Y- (42)
Indianapolis	-Y- (60)
Kokomo	-Y- (60)
Lima	-Y- (38)
Lima	-T- (52)
Muncie	-Y- (60)
Toledo	-T- (48)

N. Y. N. H. & H.

Boston	-T- (41)
Boston	-Y- (57)
Braintree	-T- (53)
Bridgeport	-T- (41)
Cranston	-Y- (57)
Danbury	-T- (41)
Framingham	-T- (41)
Hartford	-T- (41)
Hartford	-Y- (53)
Hopewell Jc.	-T- (41)
Mansfield	-T- (41)
Maybrook	-Y- (41)
Maybrook	-Y- (53)
Maybrook	-Y- (57)
Middleboro	-T- (41)
New Britain	-T- (57)
New Haven	-T- (41)
New Haven	-Y- (45)
New Haven	-Y- (53)
New Haven	-Y- (57)
New London	-T- (41)
Oakpoint	-Y- (53)
Oakpoint	-Y- (57)
Providence	-T- (41)
Providence	-Y- (45)
Providence	-Y- (53)
Putnam	-T- (41)
Readville	-T- (57)
Springfield	-T- (41)
Stamford	-T- (41)
Tounton	-T- (45)
Waterbury	-T- (41)
Willimantic	-T- (41)
Worcester	-T- (41)
Worcester	-Y- (57)

N. Y. O. & W.

Mayfield	-Y- (10)
Middletown	-Y- (10)
Norwich	-Y- (10)
Oswego	-Y- (10)
Utica	-Y- (10)

N. Y. S. & W.

Edgewater	-Y- (22)
Lt. Ferry Jc.	-Y- (26)

NIAGARA JUNCTION RY.

Niagara Falls	-T- (37)

N. & P. BELT LINE

Norfolk	-Y- (8)
Norfolk	-T- (60)
So. Norfolk	-Y- (10)

NORFOLK SOUTHERN

Norfolk	-Y- (53)
Raleigh	-Y- (60)

NORTHERN PACIFIC

Auburn	-Y- (60)
Laurel	-Y- (2)
Northtown	-Y- (2)
Seattle	-T- (46)
Spokane	-T- (46)
Tacoma	-T- (46)
Tacoma	-Y- (60)

PENN - READING

Camden	-Y- (53)
Camden (Shipyd)	-Y- (29)
Coopers Point	-Y- (6)
Pavonia	-Y- (23)

PERE MARQUETTE

Detroit	-Y- (15)
Detroit	-T- (29)
Grand Rapids	-Y- (2)
Grand Rapids	-Y- (15)
Grand Rapids	-T- (29)
Ludington	-T- (29)
Saginaw	-Y- (15)
Saginaw	-T- (29)
Toledo	-Y- (15)
Toledo	-T- (29)
Toledo	-Y- (38)

PETALUMA & SANTA ROSA

Petaluma	-Y- (3)

P. & L. E. (N. Y. C.)

Aliquippa	-Y- (2)
Aliquippa	-Y- (7)
College	-Y- (22)
Dickerson Run	-Y- (30)
Homestead	-Y- (7)
McKeesport	-Y- (5)
Monessen	-Y- (54)
New Castle Jc.	-Y- (54)
Newell	-Y- (7)
W. Columbus	-Y- (22)
W. Ellwood Jc.	-Y- (30)
W. Newton	-Y- (30)
E. Youngstown	-Y- (22)
E. Youngstown	-Y- (34)
Youngstown	-T- (54)

P. S. & N.

St. Marys	-Y- (5)
St. Marys	-Y- (19)

P. & W. VA.

Pittsburgh	-T- (3)

PORTLAND ELECTRIC

E. Portland	-T- (10)
E. Portland	-Y- (30)

READING

Allentown	-Y- (9)
Allentown	-Y- (54)
Belmont	-Y- (21)
Bethlehem	-Y- (15)
Downingtown	-Y- (54)
Lebanon	-Y- (9)
Newberry Jc.	-Y- (54)
Norristown	-Y- (15)
Port Reading	-Y- (53)
Port Reading	-Y- (57)
Port Richmond	-Y- (18)
Port Richmond	-T- (38)
Port Richmond	-Y- (60)

READING (continued)

Pottstown	-Y- (15)
Reading	-Y- (9)
Reading	-Y- (54)
Rutherford	-Y- (9)
St. Clair	-Y- (15)
Tamaqua	-Y- (9)
Wayne Jc.	-Y- (49)
Wayne Jc.	-Y- (57)
Wilmington	-Y- (54)
Woodlane	

RUTLAND

Alburgh	-Y- (4)
Burlington	-Y- (4)
Norwood	-Y- (4)
Rutland	-Y- (4)
Rutland	-T- (19)

SACRAMENTO NORTHERN

Marysville	-Y- (26)
Sacramento	-Y- (26)

ST. L. - S. F.

Armory Jc.	-Y- (60)
Birmingham	-T- (53)
Birmingham	-Y- (60)
Chaffe	-Y- (60)
Enid	-T- (28)
Enid	-Y- (60)
Ft. Scott	-Y- (60)
Ft. Smith	-Y- (60)
Joplin	-Y- (60)
Kansas City	-Y- (60)
Memphis	-T- (28)
Memphis	-Y- (60)
Monett	-Y- (60)
Newburg	-Y- (60)
Oklahoma City	-T- (28)
Oklahoma City	-Y- (60)
Sherman	-Y- (60)
Springfield	-Y- (60)

ST. L. - S. F. (continued)

Thayer	-Y- (60)
W. Tulsa	-T- (28)
W. Tulsa	-Y- (60)
Wichita	-T- (28)
Wichita	-Y- (60)

ST. LOUIS - SOUTHWESTERN

Illmo	-Y- (7)
Illmo	-T- (52)
Jonesboro	-Y- (52)
Pine Bluff	-T- (10)
Pine Bluff	-Y- (52)
Shreveport	-Y- (52)
Texarkana	-Y- (52)

SAN DIEGO & ARIZONA EASTERN

San Diego	-Y- (6)

SEABOARD AIR LINE

Americus	-Y- (16)
Americus	-Y- (30)
Atlanta	-T- (22)
Atlanta	-T- (30)
Baldwin	-Y- (16)
Baldwin	-Y- (30)
Birmingham	-T- (16)
Birmingham	-T- (22)
Charleston	-Y- (16)
Charleston	-Y- (30)
Charlotte	-Y- (30)
Charlotte	-Y- (41)
Columbia	-Y- (16)
Columbia	-Y- (30)
Columbus	-Y- (16)
Columbus	-Y- (30)
Durham	-Y- (30)
Durham	-Y- (41)
Hamlet	-T- (16)
Hamlet	-T- (30)
Henderson	-Y- (30)
Henderson	-Y- (41)

SEABOARD AIR LINE (continued)

Jacksonville	-T-	(22)
Jacksonville	-T-	(41)
Macon	-Y-	(16)
Macon	-Y-	(30)
Miami	-T-	(41)
Miami	-T-	(52)
Norfolk	-Y-	(22)
Norfolk	-Y-	(30)
Raleigh	-Y-	(30)
Raleigh	-Y-	(41)
Richmond	-T-	(16)
Richmond	-T-	(30)
St. Petersburg	-Y-	(16)
St. Petersburg	-Y-	(30)
Savannah	-T-	(16)
Savannah	-T-	(22)
Savannah	-T-	(30)
Savannah	-T-	(41)
Tallahassee	-Y-	(16)
Tallahassee	-Y-	(30)
Tampa	-T-	(16)
Tampa	-T-	(30)
Wildwood	-Y-	(16)
Wildwood	-Y-	(30)
Wilmington	-Y-	(16)
Wilmington	-Y-	(30)

SOUTHERN PACIFIC

Avondale	-Y-	(51)
Dallas	-T-	(8)
Dallas	-Y-	(33)
El Paso	-Y-	(33)
El Paso	-T-	(60)
Englewood	-Y-	(8)
Houston	-T-	(4)
Los Angeles	-Y-	(33)
Los Angeles	-Y-	(53)
Martinez	-Y-	(33)
Martinez	-Y-	(53)
New Orleans	-T-	(39)
Oakland	-Y-	(28)

SOUTHERN PACIFIC (continued)

Oakland	-Y-	(47)
Portland	-Y-	(4)
San Antonio	-Y-	(8)
San Antonio	-T-	(60)
San Francisco	-Y-	(33)
San Francisco	-Y-	(53)

S. P. & S.

Portland	-Y-	(47)
Vancouver	-Y-	(47)
Wishram	-Y-	(47)

T. A. & G.

Chattanooga	-Y-	(22)
Gadsden	-Y-	(22)

TENNESSEE CENTRAL

Harriman	-Y-	(59)
Monterey	-Y-	(59)
Nashville	-Y-	(59)

TENNESSEE COP.

Copperhill	-T-	(27)
Copperhill	-T-	(43)
Copperhill	-T-	(60)

TEXAS & PACIFIC

Alexandria	-Y-	(13)
Big Spring	-Y-	(41)
Chautoqua	-Y-	(41)
Dallas	-Y-	(41)
El Paso	-Y-	(30)
Ft. Worth	-Y-	(30)
Ft. Worth	-Y-	(41)
Longview	-Y-	(30)
Moneola	-Y-	(41)
New Orleans	-Y-	(13)
Shreveport	-Y-	(13)
Shreveport	-T-	(38)
Texarkana	-Y-	(13)
Texarkana	-T-	(38)
Toyah	-Y-	(41)

TOLEDO TERMINAL

Toledo	-T- (26)

UNION

Pittsburgh	-Y- (21)
Pittsburgh	-Y- (25)

UNION PACIFIC

Brigham	-Y- (60)
Butte	-Y- (45)
Caliente	-Y- (60)
Centralia	-Y- (40)
Cheyenne	-T- (60)
Council Bluffs	-T- (49)
Denver	-T- (18)
Denver	-T- (60)
Ellis	-Y- (45)
Glenns Ferry	-Y- (45)
Grand Is.	-Y- (60)
Greeley	-Y- (60)
Green River	-Y- (45)
Hastings	-Y- (60)
Hermiston	-Y- (40)
Hugo	-Y- (60)
Huntingdon	-Y- (45)
Idaho Falls	-Y- (45)
Junction City	-Y- (45)
Kansas City	-Y- (58)
La Grande	-Y- (45)
Laramie	-Y- (45)
La Salle	-Y- (60)
Las Vegas	-Y- (60)
Los Angeles	-T- (60)
Lynndyl	-Y- (60)
Marysville	-Y- (45)
Milford	-Y- (60)
Montpelier	-Y- (45)
Nampa	-T- (45)
Nampa	-T- (60)
N. Platte	-T- (45)
N. Platte	-T- (60)
Oakley	-Y- (45)

UNION PACIFIC (continued)

Ogden	-T- (47)
Ogden	-T- (60)
Omaha	-T- (18)
Omaha	-T- (60)
Pendleton	-Y- (40)
Pocatello	-T- (45)
Pocatello	-T- (60)
Portland	-T- (40)
Portland	-T- (60)
Rawlins	-Y- (45)
Reith	-Y- (45)
Salina	-Y- (45)
Salt Lake City	-T- (18)
Salt Lake City	-T- (47)
San Bernardino	-Y- (60)
Seattle	-Y- (40)
Sharon Springs	-Y- (45)
Sidney	-Y- (60)
Spokane	-Y- (40)
The Dalles	-Y- (40)
Topeka	-Y- (45)
Yermo	-Y- (60)

UTAH IDAHO CENTRAL

Ogden	-Y- (37)

VIRGINIAN

Elmore	-Y- (17)
Norfolk	-Y- (17)
Roanoke	-Y- (17)

WABASH

Decatur	-Y- (47)
Detroit	-Y- (10)

WESTERN MARYLAND

Cumberland	-Y- (5)
Elkins	-Y- (5)
Hagerstown	-Y- (5)
No. Junction	-Y- (51)
Port Covington	-Y- (5)

WESTERN PACIFIC

Elko	-Y-	(10)
Keddie	-Y-	(10)
Oroville	-Y-	(10)
Ortega	-Y-	(21)
Portola	-Y-	(10)
Sacramento	-Y-	(10)
S.F. - Oakland	-T-	(21)
San Jose	-Y-	(10)
Wendover	-Y-	(10)
Winnemucca	-Y-	(10)

WHEELING & LAKE ERIE

Brewster	-T-	(30)
Brewster	-Y-	(46)
Canton	-T-	(30)
Canton	-Y-	(46)

W. & L. E. (continued)

Cleveland	-Y-	(4)
Cleveland	-Y-	(30)
Cleveland	-T-	(46)
Dillon Vale	-T-	(30)
Dillon Vale	-Y-	(46)
Huron	-Y-	(30)
Lorain	-Y-	(30)
Lorain	-Y-	(46)
Mingo Jc.	-T-	(30)
Mingo Jc.	-Y-	(46)
Norwalk	-Y-	(30)
Toledo	-Y-	(46)
Zanesville	-T-	(30)
Zanesville	-Y-	(46)

YOUNGSTOWN & NORTHERN

Youngstown	-Y-	(31)
Youngstown	-Y-	(39)

* * *

What Should a Track Relay's Resistance Be?

The factors which govern the choice of track relay resistance are:

1. The minimum ballast resistance.
2. The rail and bonding resistance.
3. The length of the track circuit.
4. The shunting time required.

When these factors are favorable, a higher resistance track relay may be used. A rough rule of thumb is that the resistance of the relay should not exceed the minimum ballast resistance per 1000 feet of track. Under similar conditions, longer track circuits can be operated with a 2-ohm relay than can be operated with a 4-ohm relay. For better rusty rail protection and quicker shunting on shorter track sections, the best results are obtained by using a standard low resistance relay with external resistance connected between the relay and track. See Development Sheet D21.3001 for a discussion of this circuit.

The eventual choice is often modified by the necessity of adhering to the standards already established on each railroad.

* * *

How Outer Roundels Affect Signal Range

To help you to estimate quickly what reduction in signal range you can anticipate with the addition of an outer deflecting or spredlite roundel, two tabulations follow. The first applies to Type SA stepped-lens signals, the second to Type SA compound-lens signals. The figures are based on calculations which are found in Pamphlet 530, "How to Select the Proper Optical Combination- - -"

TABLE I. COMPARISON OF SIGNAL RANGES OBTAINABLE WITH TYPE SA STEPPED-LENS SIGNALS

Outer Roundel	11.3V., 14.4W. Lamp No. 34866-2, Burned at 10V., 12W.		8V., 13 + 3.5W. Lamp No. 34866-37, Burned at 7.2V., 11 + 3W.	
	Actual Range Obtainable	Percent	Actual Range Obtainable	Percent
None	5900	100	6500	100
15° Spredlite	2075	35	2025	31
20° Deflecting	3200	54	3250	50
30° Spredlite	1825	31	1810	28

TABLE II. COMPARISON OF SIGNAL RANGES OBTAINABLE WITH TYPE SA COMPOUND-LENS SIGNALS

Outer Roundel	4V., 3W. Lamp No. 34866-35, Burned at 4V., 3W.		10V., 5W. Lamp No. 34866-38, Burned at 9V., 4.25W.	
	Actual Range Obtainable	Percent	Actual Range Obtainable	Percent
None	4525	100	5300	100
15° Spredlite	1225	27	1650	31
20° Deflecting	1825	40	2425	46
30° Spredlite	950	21	1400	26

* * *

"Desk Type" Control Machine

Clarification of this term seems necessary because of a recent misinterpretation.

A "desk type" control machine, whether for the control of a cTc installation or other system, is a machine designed to be placed on the top of a desk or a table. It is not provided with a base for mounting it on the floor.

It is hoped that this explanation will prevent the wrong use of the term "desk type" when referring to a floor-mounted control machine equipped with a desk.

* * *

September Birthdays

The following engineers in the signaling field celebrate their birthdays in September:

A. L. Essman, principal assistant signal engineer, C.B.&Q., Chicago, Ill., September 20, 1906.

C. M. Duffy, assistant to signal engineer, C.R.I.&P., El Reno, Okla., September 8, 1883.

C. E. Hartvig, assistant signal engineer, C.R.I.&P., Chicago, Ill., September 22, 1888.

Bernard Walter Molis, signal engineer, Denver and Rio Grande Western, Denver, Colorado, September 10, 1893.

H. E. Brashares, superintendent of signals, Great Northern, St. Paul, Minn., September 5, 1881.

C. F. Grundy, signal engineer, Kansas City Southern, Kansas City, Mo., September 16, 1894.

A. B. Armistead, assistant superintendent signals, N.&W., Roanoke, Va., September 25, 1904.

E. W. Reich, superintendent telegraph and signals, Reading,
Philadelphia, Pa., September 11, 1894.
Joseph Roy De Priest, superintendent telegraph and signals,
Seaboard Air Line, Norfolk, Va., September 1, 1911.

* * *

Elmer Knapp Dies

After several months' illness, Elmer Knapp, our purchasing agent, died in Strong Memorial Hospital, Rochester, the evening of July 22.

Elmer was born in Rochester, March 30, 1891, and attended grade school and East High school there. He graduated from Rochester Athenaeum and Mechanics Institute (now the Rochester Institute of Technology) in 1911. His first job was with us in 1910 when he worked during his summer vacation. He returned in July 1911 after his graduation and stayed until February, 1912, when he went to the Peerless Check Protection Co., drafting, tool making, and purchasing. From 1916 to 1920 he was purchasing agent for the Davis Machine Tool Co. and, from 1920 to 1925, purchasing agent for the Rochester Folding Box Co.

In 1925 Elmer returned to us for the second time, as assistant purchasing agent, later advancing to purchasing agent.

His cheerful personality is sadly missed around 801 West Avenue by his many friends and associates. Our sympathy goes out to his wife, daughter, two sons, and his mother in their bereavement.

G-R-S NEWS
July 1946

Roller Bearings for Switches

Heretofore it has been the practice to order roller bearings for switches to suit the particular switch on which the bearing is to be installed. ED Sheet No. 28728 contains a graph from which the heavy duty or light duty roller bearing can be selected, depending upon the length of switch and weight of rail.

Some difficulties have been reported by the district offices wherein the light duty bearing has deflected and bent due to the weight of the switch rail and parts. This indicates that the dividing line between heavy duty and light duty was a little too close to the high side and that we were attempting to carry too heavy a load with the light duty bearing.

Opinions have been expressed by two railroads, the Missouri Pacific and the Northern Pacific, along with our Chicago and St. Louis Offices, that all switches regardless of their length and size of rail should be equipped with the heavy duty bearing in future. This is an advantage from the standpoint of standardization and will cause less difficulty in carrying parts in railroad stock and in selecting the roller bearing for a given layout.

In view of the facts and opinions expressed above, we will in future furnish nothing but the heavy duty roller bearing.

* * *

General Railway Signal Offers Airway Control

System Utilizes Railroad Track-Circuit Principle

Seventh of a Series

This is the seventh of a series of articles dealing with all-weather proposals. Another installment will appear in a forthcoming issue of AMERICAN AVIATION.

WHILE MOST of the companies now developing all weather flying aids have concentrated their attention on the navigation, instrument landing and airport traffic control aspects, two of the proposals offered at the recent Pentagon conference placed primary importance on the airway traffic control and automatic posting elements of the problem.

The first of these proposals was offered by Teleregister Corp. and consists of a four stage system which was described in detail in AMERICAN AVIATION, Nov. 15, 1945. A test installation of the first stage in this system was made by the CAA at Washington National Airport in 1940, and further experimentation has been proposed almost every year since then, only to be postponed when the necessary funds were stricken from the CAA budget.

The second proposal was that of General Railway Signal Co. and was based on that company's long experience in railway signaling, utilizing the equivalent of the track-circuit principle on which all railroad control now is based.

Generally speaking, under the GRS proposal, each airway would be equipped with suitable radio or radar beacons to permit the pilot to follow a defined course. Next the airway would be divided into blocks by phantom walls intersecting it, the length of the blocks ranging from 10 miles or less to 50 miles or more as traffic and physical conditions dictate. The airway would further be divided into 1,000-ft. altitude layers, in effect providing 16 traffic levels between 2,000 and 17,000 ft.

Automatic equipment would be provided on the ground and in each aircraft to determine the occupancy of each block at each altitude. After determining that a particular block was occupied at a particular altitude, the ground station would then signal the occupant as to whether the next block was occupied. These signals could be by means of colored lights similar to railroad cab lights, with green meaning it was all right to proceed, and red meaning the next block was occupied and it would be necessary to hold, or change course or altitude. At the same time a dial would be provided in each aircraft with a distinctive position for each altitude, so that the pilot could look in on other altitudes before changing his own.

The whole GRS plan is based on a closed circuit principle in which provision is made so that failure of a device or part of a system cannot result in an unsafe condition even though it causes delays in traffic. This principle applies to all vital parts of the system—those which effect safety—but in the interest of economy does not apply to non-vital parts. For example, it is conceivable that a manual control can be superimposed by a ground agency so as to give a less favorable indication to the pilot, but it would not be possible to superimpose a manual control to give a more favorable indication than the existing condition.

Equipment, according to GRS, would be relatively simple and inexpensive, while the airborne equipment weight would not be of serious consequence.

While GRS has not as yet released details as to how these results would be effected, it states that its system can be divided into two parts—the traffic control and safety system which represents the latest development in railway traffic control techniques, and the electronic components which are necessary to adapt this traffic control system for airway use.

Basically the system requires the establishment of a chain of relatively low cost ground beacon signal stations along an airway, and the installation of a lightweight transponder beacon and signal indication on each aircraft. Weight of the airborne equipment would be similar to the weight of AN/APN-19 equipment plus signal indicators.

Length of the airway sectors or blocks will be determined by spacing of the ground stations, which will in turn be determined by study of the traffic conditions to be encountered along each portion of an airway. All ground stations will be fully automatic in operation and will be connected together by ground radio links.

In operation, each block station will determine the presence of equipped aircraft at each altitude within the block under its surveillance. This information will be passed continuously and automatically along the airway over the ground radio links. Depending on the occupancy condition at each altitude in a given block, and in the adjacent blocks, each ground station will transmit the proper signal information to aircraft at all altitudes within the block. The exchange of signal information within a given block will take place in a closed sequence, whereby only one aircraft at a time is able to receive signal information, and consequently clearance to proceed.

As a fundamental principle of the system, an aircraft must show occupancy in a certain region in space before the ground station having surveillance over that region is permitted to send signal information to that region. At the same time, absolute isolation between adjacent regions in space will be accomplished by means of yet undisclosed techniques. Information supplied by the system will further make it possible for the pilot to determine that he can change course or altitude safely as well as proceed along the airway.

Absolute identity of an aircraft by a given ground station has not been considered to be a requisite for the safety features of the system. However, for navigation it has been considered important for each ground station to identify itself to all aircraft, and provisions are being made to give each ground station a distinctive code identification which will be transmitted to the aircraft as part of the signal information. Means have further been provided so that a pilot will know when he has reached a block boundary so that he may hold if necessary within a given block and a given altitude.

Despite the very scant information revealed to date, General Railway Signal Co. is understood to have many of the elements of its proposed system at a high stage of development, and to be planning an experimental airway installation sometime this year. The basic electronic elements for this trial will probably consist of radar beacons similar to the Hazletine Lanac system combined with the automatic interlocking relay set-up used by GRS in railway traffic control, and in an experimental airport traffic control set-up at LaGuardia Field.

Offering a comprehensive consulting service in the field of air transportation covering economic, technical and financial evaluations of traffic, equipment and management problems.

ALVIN P. ADAMS AND ASSOCIATES

Aviation Consultants

9126 SUNSET BOULEVARD, LOS ANGELES 46, CALIFORNIA

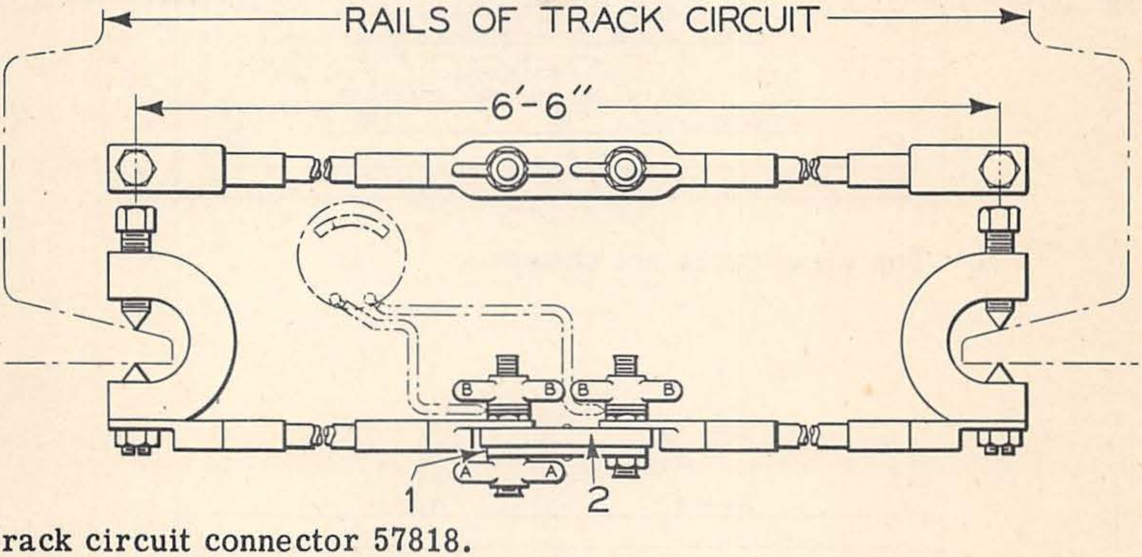
Airway Control

On the opposite page is a reproduction of page 43 of the June 1, 1946 issue of American Aviation, which no doubt will make interesting reading for all who have been wondering what we have been doing in the field of airway traffic control.

* * *

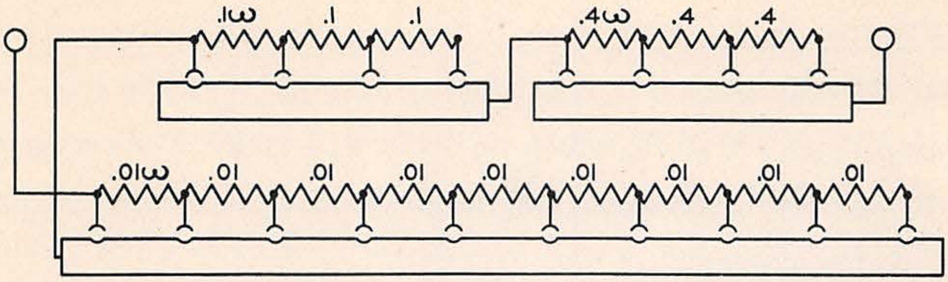
Handy Track Circuit Connector or Shunt

To simplify the taking of voltage and shunt resistance measurements on track circuits, there is available a connector 57818. As shown below, it consists of two C-clamps, to each of which is attached a flexible lead.

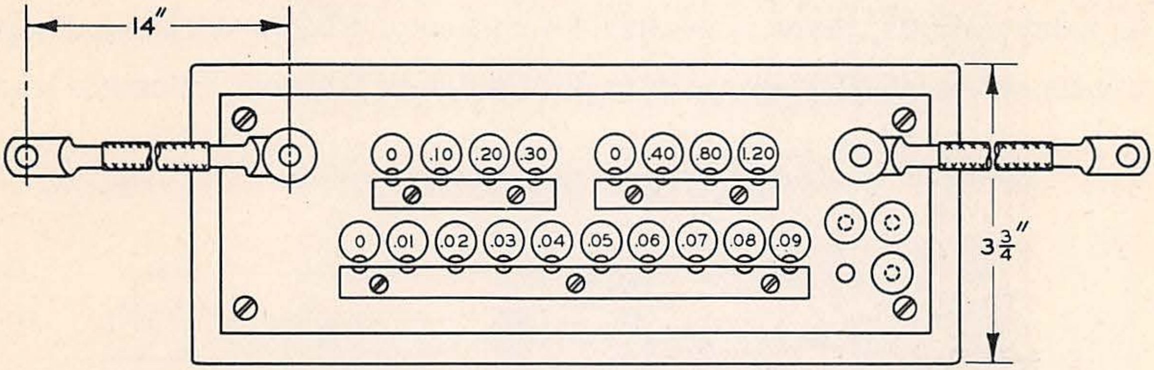


Track circuit connector 57818.

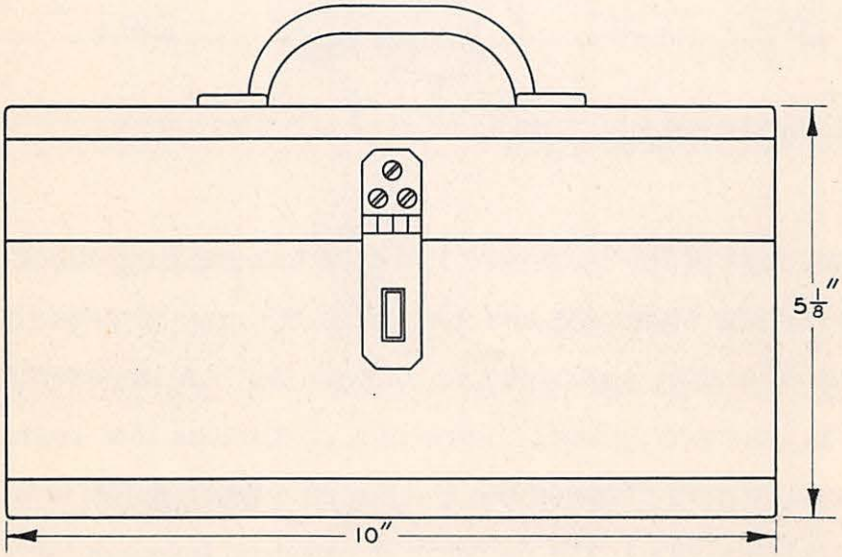
The other ends of the leads are fastened to insulating block 2 by the posts of terminal nuts BB and AA. Nuts BB may be used to fasten the terminals of testing apparatus as shown. Nut AA is essentially a switch. When it is screwed up tight, there is a continuous low-resistance (0.005 ohm) metallic path between the C-clamps. When nut A is backed away from metallic strap 1, the metallic connection between the C-clamps is broken.


.1ω
.1
.1
.4ω
.4
.4
.01ω
.01
.01
.01
.01
.01
.01
.01
.01

(a) Connection diagram


14″
0
.10
.20
.30
0
.40
.80
1.20
0
.01
.02
.03
.04
.05
.06
.07
.08
.09
3 3/4″

(b) Top view (cover not shown)



Shunt test box 58790

The C-clamps are provided with pointed set screws. The hardened steel points penetrate the rust and scale on the rail base to insure a good connection. A 1/2-inch hexagonal socket wrench fits the set screws.

This makes a very convenient accessory to shunt test box 58790, described below.

* * *

Shunt Test Box for Track Circuits

Shunt test box 58790 has a capacity of from 0.01 to 1.59 ohms in 0.01-ohm steps. It is particularly adapted to making accurate shunt tests on track circuits.

The illustration on page 4 shows the dimensions of the shunt test box and its internal wiring.

Connector 57818 makes a handy accessory to this test box.

* * *

"On" Time Meter for Testing Coded Track Circuits

The main purpose of the d-c. "on" time meter (58460) is to indicate the percent of time the coding contact of a code-responsive relay remains closed during a complete coding cycle. This instrument can also be used as a 4-volt d-c. voltmeter, and it can be used to check the resistance of bonded rail joints.

As shown in Figure 1 on page 6, the meter is enclosed in a wooden case, 9 inches square and 4 inches high when closed. Two flexible leads 4 feet long are furnished, a black lead for the negative terminal and a red lead for the positive terminal. Energy is supplied by a 1.5-volt flashlight cell, which is located within the case. Instruction tag 55085-151 is clipped inside the cover.

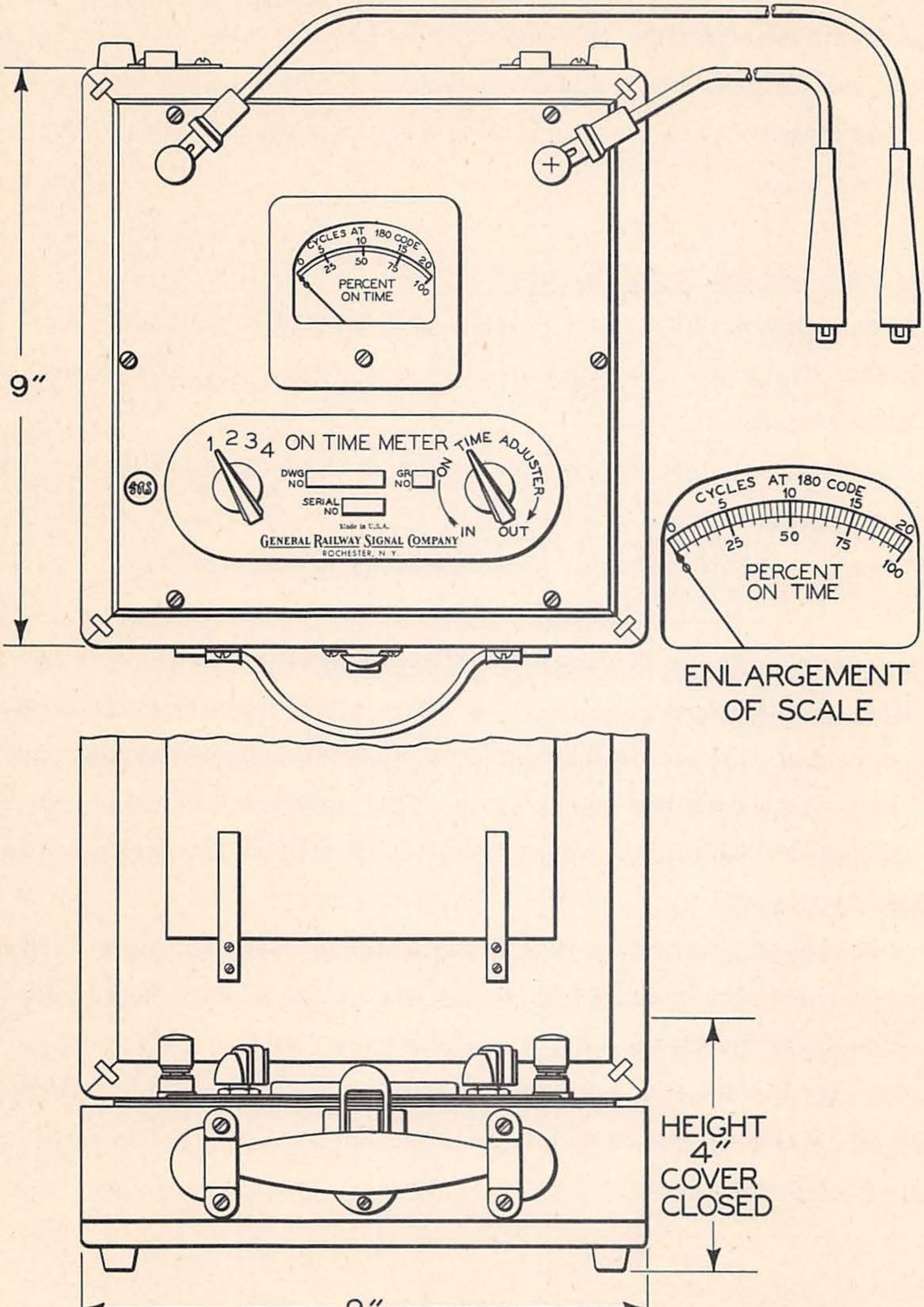
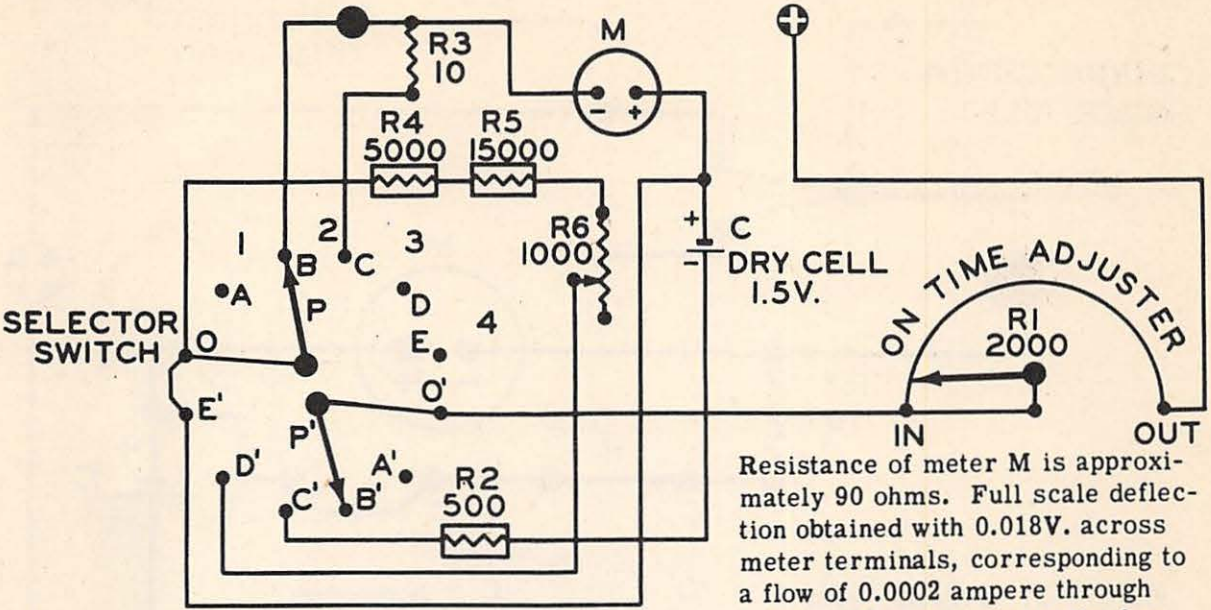

9"
+
CYCLES AT 180 CODE
5 10 15 20
0 25 50 75 100
PERCENT ON TIME
1 2 3 4 ON TIME METER
TIME ADJUSTER
ON
IN
OUT
DWG NO
GR NO
SERIAL NO
Made in U.S.A.
GENERAL RAILWAY SIGNAL COMPANY
ROCHESTER, N.Y.
GRS
ENLARGEMENT OF SCALE
HEIGHT 4" COVER CLOSED
9"

Figure 1. "On" time meter 58460.



Resistance of meter M is approximately 90 ohms. Full scale deflection obtained with 0.018V. across meter terminals, corresponding to a flow of 0.0002 ampere through meter. R6 is adjusted in the factory to obtain full scale deflection with 4 volts across the + and - terminals of the instrument case.

Figure 2. Circuit diagram of d-c. "on" time meter, shown looking at face of panel. Selector switch is in position 1, shunting meter.

Figure 2 shows the internal wiring of the meter as viewed looking at face of panel. Contact arms P and P1 on selector switch both move together in a clockwise direction as the knob on the selector switch is moved from position 1 toward position 4. Contact arms P and P1 are shown as they are positioned when the selector switch is set at position 1. In this position the meter is shunted.

The indicating meter used in this instrument is essentially a standard movable coil meter (d'Arsonval movement), having a permanent magnet field. With the meter connected to indicate the percent "on" or closed time of a coding contact, as shown in Figure 3, resistor R3 is connected in shunt across the coil. When the coding contact under test closes, energy from the flashlight cell C is applied to the coil, causing it to move the pointer up the scale. When the coding contact opens, energy from the flashlight cell is cut off, and the shunt circuit through resistor R3 causes a retarding or dampening effect on the movement of the coil as it starts to return towards zero.

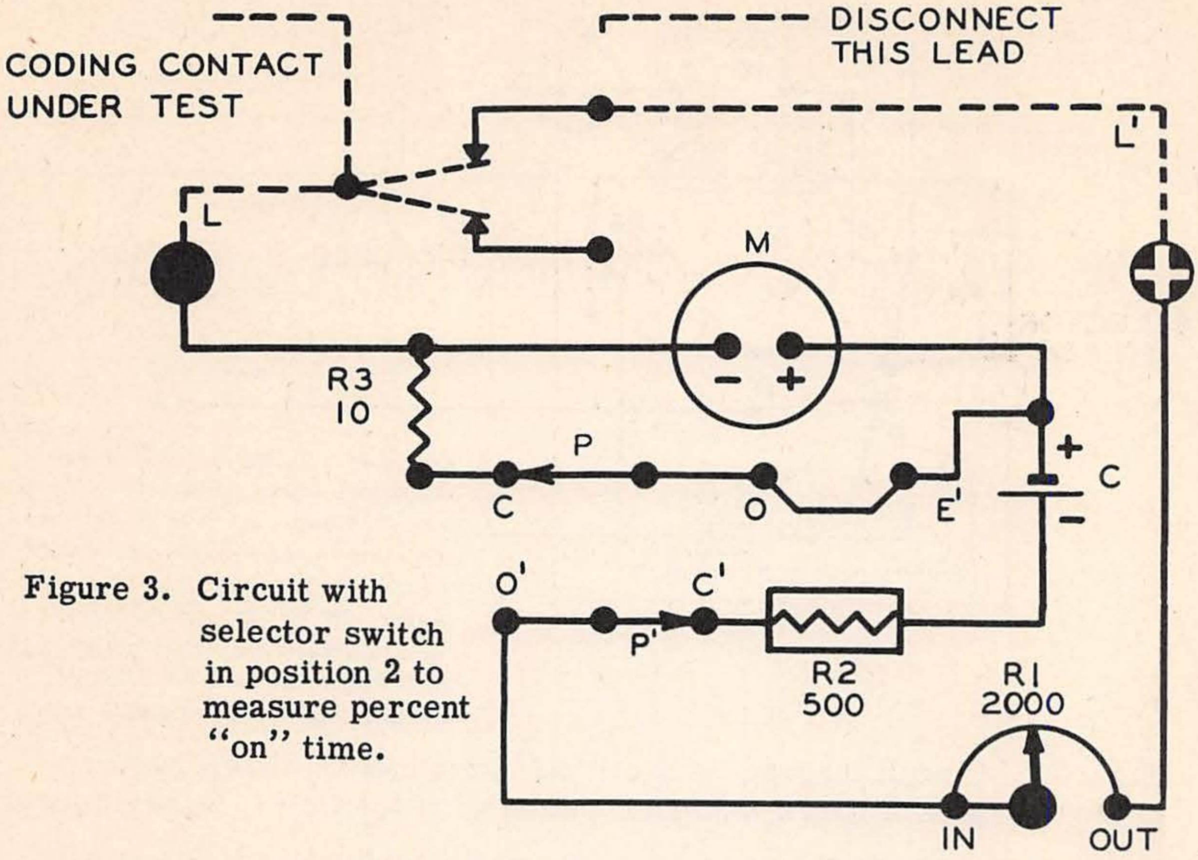


Figure 3. Circuit with selector switch in position 2 to measure percent "on" time.

As the coding contact continues to operate, the pointer vibrates through a small arc. The reading is taken at the center of the arc of movement.

1. To measure the percent of "on" time, proceed as follows:
   (a). Refer to Figure 3. Set selector switch at position 2. Before connecting to coding contacts, connect black and red flexible leads L and L1 together and adjust rheostat R1 until meter registers 100 percent.
   (b). Disconnect one of the normal leads from the coding contact and then connect posts on panel to coding contacts as shown in Figure 3. The meter pointer will indicate the percent "on" time of the coding contact.
   (c). Check 100 percent "on" time as described under (a) occasionally during tests to be sure that knob of R1 has not been moved.

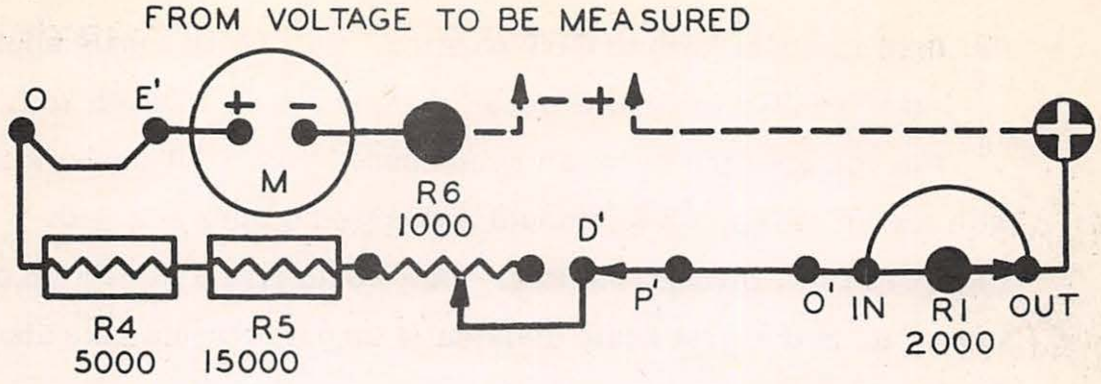

FROM VOLTAGE TO BE MEASURED
O
E'
+
−
M
− +
R6
1000
D'
P'
O'
IN
R1
OUT
2000
R4
5000
R5
15000

Figure 4. Circuit with selector switch in position 3 to use as a 4-volt d-c. voltmeter.

2. To use as a 4-volt d-c. voltmeter:

(a). Refer to Figure 4. Set selector switch in position 3. Turn rheostat knob to OUT position.

(b). Connect leads to voltage to be measured. Each quarter division of the meter scale equals 1 volt. Meter will measure accurately to within 2 percent.

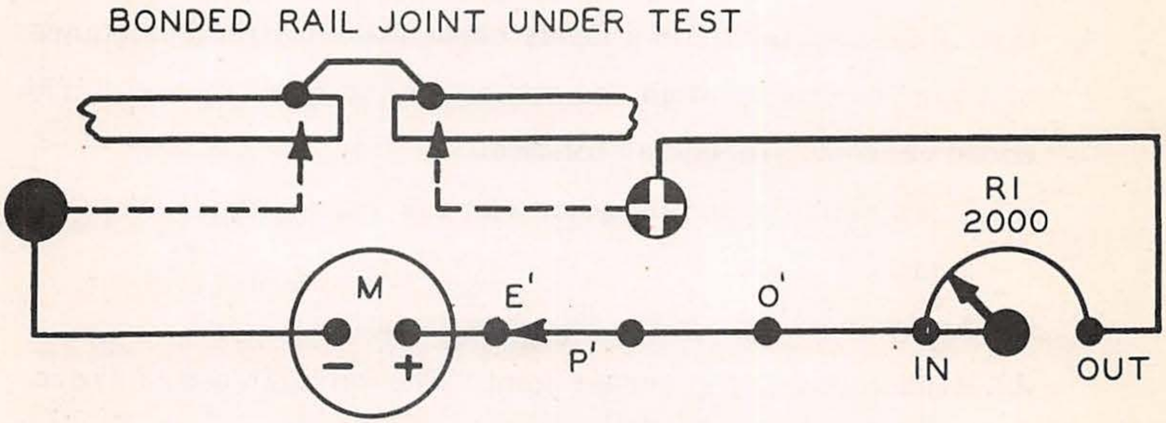

BONDED RAIL JOINT UNDER TEST
R1
2000
M
E'
O'
−
+
P'
IN
OUT

Figure 5. Circuit with selector switch in position 4 to test bonded rail joints.

3. To check resistance of bonded rail joints:

(a). Refer to Figure 5. Set selector switch in position 4. Turn rheostat knob to IN position. Connect leads to rails as shown in Figure 4, making sure that a good contact is secured. Full scale equals 0.4 volt. If deflection is less than the first two scale divisions (0.02 volt), then - - -

(b). Turn rheostat knob to OUT position. Full scale equals approximately 0.018 volt. One scale division equals 0.00045 volt.

The voltage drop across a good bonded joint (100-pound rail), with meter set as in 3(b), should not exceed 0.0002 volt with 1 ampere flow, through the rail. This would give a deflection of about half of the first scale division; 4 amperes would give about 2 scale divisions.

If voltage readings are taken with coded current in rail, comparison of drops across adjacent rail joints will indicate a joint with unduly high resistance. It is advisable to measure coded current to track and track relay in order to obtain some idea as to variation in rail current through the length of the track circuit, as voltage drop across joints will increase approaching the battery end.

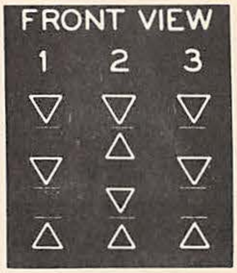
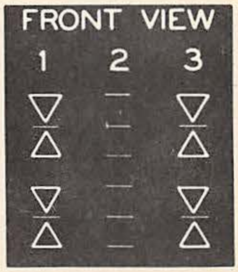
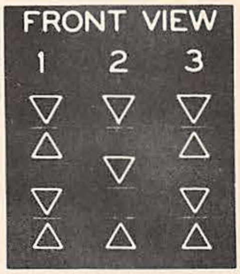
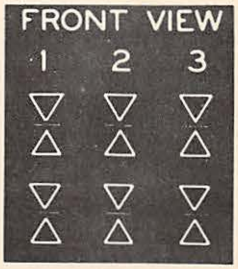
4. If it is desired to obtain a fairly close value for the resistance of a joint having too high resistance, as indicated by test 3 with coded current, proceed as follows:
   (a). Shunt rails beyond the joint with low resistance (0.01 to 0.02 ohm).
   (b). Apply about 5 amperes steady current.
   (c). Read voltage drop across joint. The calculated resistance should be reasonably accurate.

* * *

Biased Neutral Relays

Supplementing the information on biased neutral relays which appeared in the November 1945 issue of G-R-S NEWS, we list on the next four pages the relays which have been furnished in the Type B and Type K lines, showing the resistance, pickup and working values, and ordering references.

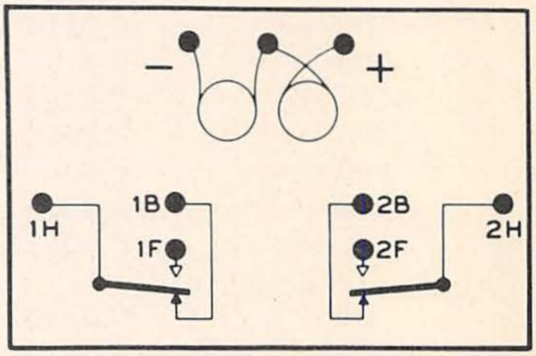
I. TYPE B SIZE 1 BIASED NEUTRAL RELAYS

Resistance in ohms	MAX. PU & WC IN AMPS.	Ordering Reference	Contacts
63	0.0250	56001-776 Gr. 5	2FB4F2B 
100	0.0214	" 2	
200	0.0156	" 8	
250	0.0135	" 1	
500	0.0098	" 7	
600	0.0087	" 3	
1000	0.0072	" 4	
2100	0.0048	" 6	
63	0.0232	56001-765 Gr. 5	4FB 
100	0.0200	" 2	
200	0.0156	" 8	
250	0.0126	" 1	
500	0.0098	" 7	
600	0.0080	" 3	
1000	0.0068	" 4	
2100	0.0048	" 6	
63	0.0250	56001-752 Gr. 5	4FB2F1B 
100	0.0214	" 2	
200	0.0156	" 8	
250	0.0135	" 1	
500	0.0098	" 7	
600	0.0087	" 3	
1000	0.0072	" 4	
2100	0.0048	" 6	
63	0.0250	56001-724 Gr. 5	6FB 
100	0.0214	" 2	
200	0.0156	" 8	
250	0.0135	" 1	
500	0.0098	" 7	
600	0.0087	" 3	
1000	0.0072	" 4	
2100	0.0048	" 6	

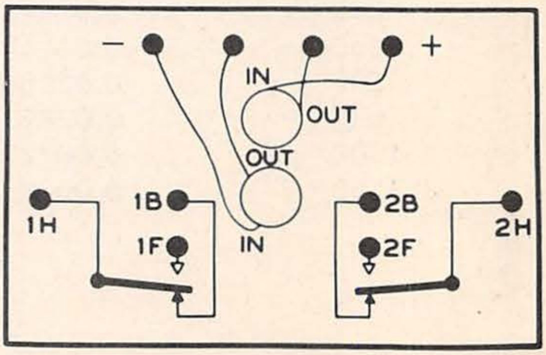
II. TYPE K SIZE 2 BIASED NEUTRAL RELAYS

		Ordering References	
Resistance in ohms	MAX. PU & WC IN AMPS.	With Single Term. Block	With Double Term. Block
50	0.0300	53000-305 Gr. 11	53000-306 Gr. 11
60	0.0240	" 12	" 12
100	0.0190	" 13	" 13
150	0.0160	" 14	" 14
200	0.0150	" 15	" 15
250	0.0140	" 61	" 61
300	0.0130	" 16	" 16
400	0.0115	" 17	" 17
450	0.0105	" 63	" 63
500	0.0110	" 18	" 18
600	0.0100	" 19	" 19
750	0.0095	" 20	" 20
800	0.0090	" 21	" 21
1000	0.0075	" 22	" 22
1500	0.0061	" 24	" 24
2000	0.0045	" 25	" 25
13240	0.0085	" 62	" 62

Internal connections with single terminal block



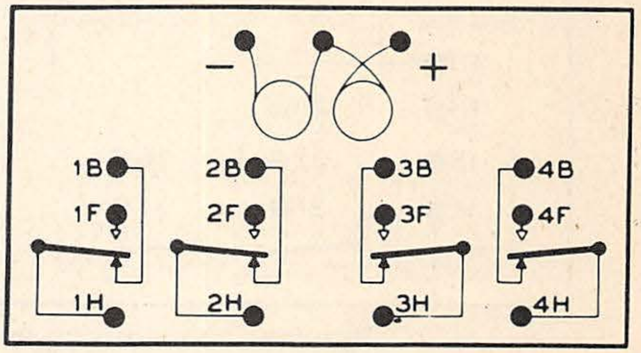
Internal connections with double terminal block



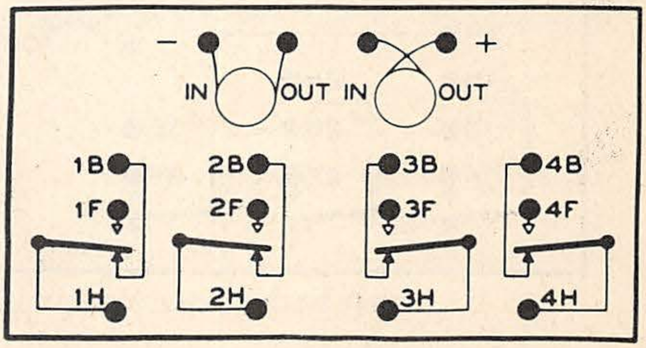
III. TYPE K SIZE 4 BIASED NEUTRAL RELAYS

Resistance in ohms	MAX. PU & WC IN AMPS.	Ordering References With Single Term. Block	Ordering References With Double Term. Block
2	0.1100	53000-307 Gr. 2	
4	0.0750	” 3	
50	0.0240	” 6	53000-308 Gr. 6
66	0.0180		” 20
100	0.0180	” 7	” 7
136	0.0170	” 8	” 8
150	0.0155		” 19
200	0.0130	” 9	” 9
250	0.0125	” 10	” 10
300	0.0125	” 11	” 11
400	0.0100	” 12	” 12
450	0.0095	” 13	” 13
500	0.0095	” 15	” 15
670	0.0090	” 16	” 16
750	0.0080	” 17	” 17
1000	0.0065	” 18	” 18

Internal connections with single terminal block

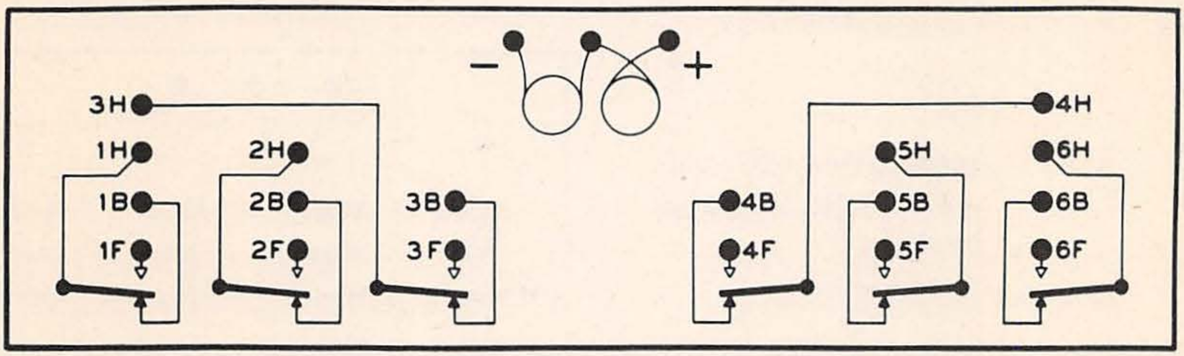

−
+
1B
2B
3B
4B
1F
2F
3F
4F
1H
2H
3H
4H

Internal connections with double terminal block

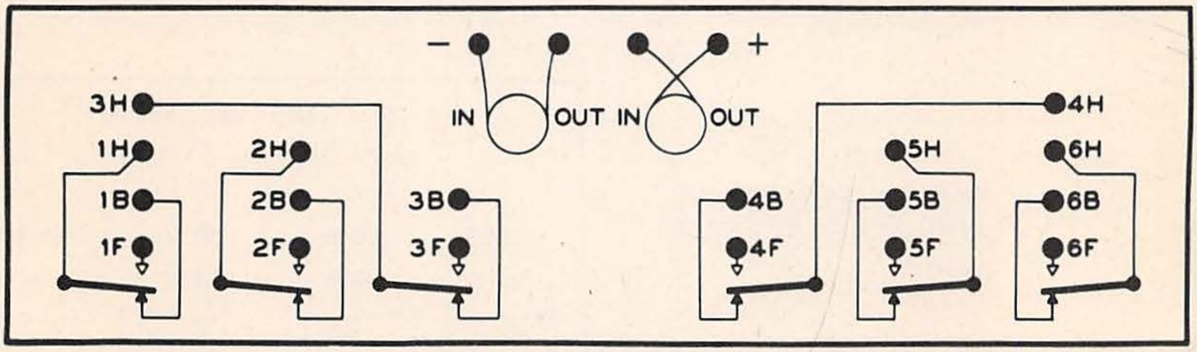

−
+
IN
OUT
IN
OUT
1B
2B
3B
4B
1F
2F
3F
4F
1H
2H
3H
4H

IV. TYPE K SIZE 6 BIASED NEUTRAL RELAYS

Resistance in ohms	MAX. PU & WC IN AMPS.	Ordering References With Single Term. Block	Ordering References With Double Term. Block
2	0.1240	53000-309 Gr. 2	
4	0.0850	" 3	
50	0.0280	" 6	53000-311 Gr. 6
66	0.0205	" 20	" 20
100	0.0205	" 7	" 7
136	0.0190	" 8	" 8
150	0.0175	" 19	" 19
200	0.0145	" 9	" 9
250	0.0140	" 10	" 10
300	0.0140	" 11	" 11
400	0.0115	" 12	" 12
450	0.0105	" 13	" 13
500	0.0105	" 15	" 15
670	0.0100	" 16	" 16
750	0.0090	" 17	" 17
1000	0.0075	" 18	" 18


−
+
3H
1H
2H
1B
2B
3B
1F
2F
3F
4H
5H
6H
4B
5B
6B
4F
5F
6F

Internal connections with single terminal block


−
+
IN
OUT
IN
OUT
3H
1H
2H
1B
2B
3B
1F
2F
3F
4H
5H
6H
4B
5B
6B
4F
5F
6F

Internal connections with double terminal block

August Birthdays

The following engineers in the signaling field celebrate their birthdays in August:

Delbert W. Fuller, sig. engr., Eastern Lines A.T. & S.F., Topeka, Kans., Aug. 12, 1886.

G. K. Thomas, sig. engr., System A.T. & S.F., Topeka, Kans., Aug. 23, 1887.

C. A. Kies, asst. supt. sig., Alton, Bloomington, Ill., Aug. 4, 1885.

H. C. Sampson, supt. sig. & tele., Alton, Bloomington, Ill., Aug. 14, 1890.

O. S. Tomkins, asst. supt. tele. & sigs., C & NW, Chicago, Ill., Aug. 25, 1881.

H. D. Abernethy, asst. sig. engr., NYC West of Buffalo, Cleveland, Ohio, Aug. 19, 1884.

Samuel Gale Raber, sig. engr., NYC & St L, Cleveland, Ohio, Aug. 2, 1892.

R. W. Meek, sig. engr., Sou. Pac. Lines (in Tex. & Lou.), Houston, Tex., Aug. 16, 1881.

G. A. Rodger, sig. engr., Wabash, Decatur, Ill., Aug. 13, 1893.

GENERAL RAILWAY SIGNAL COMPANY

G-R-S NEWS
June 1946

Model 10 Electric Switch Lock

The Model 10 switch lock is now available to fit most low switch stands. An attachment is being developed to make it possible to lock a lock rod, but the engineering details have not yet been completed.

To avoid delay in getting information to our customers, we propose to publish a development sheet describing the lock as it is now available, that is, to fit low switch stands. When the engineering details on the lock rod attachment have been completed, additional pages will be issued describing that feature.

Your comments and additions to the material presented here will be appreciated. Please mail them in within the next two weeks so that we can include them in the development sheet, thus making it more complete and useful for all who refer to it.

*

I. WHAT THE MODEL 10 SWITCH LOCK IS

The Model 10 switch lock is a compact electro-mechanical device especially developed to provide protection for hand-throw switch stands. It can be applied to most low switch stands in common use, with or without lock rods, and to hand-operated switch machines.

Control may be manual, semi-automatic, or automatic. An interlocked emergency release is available as an optional feature.

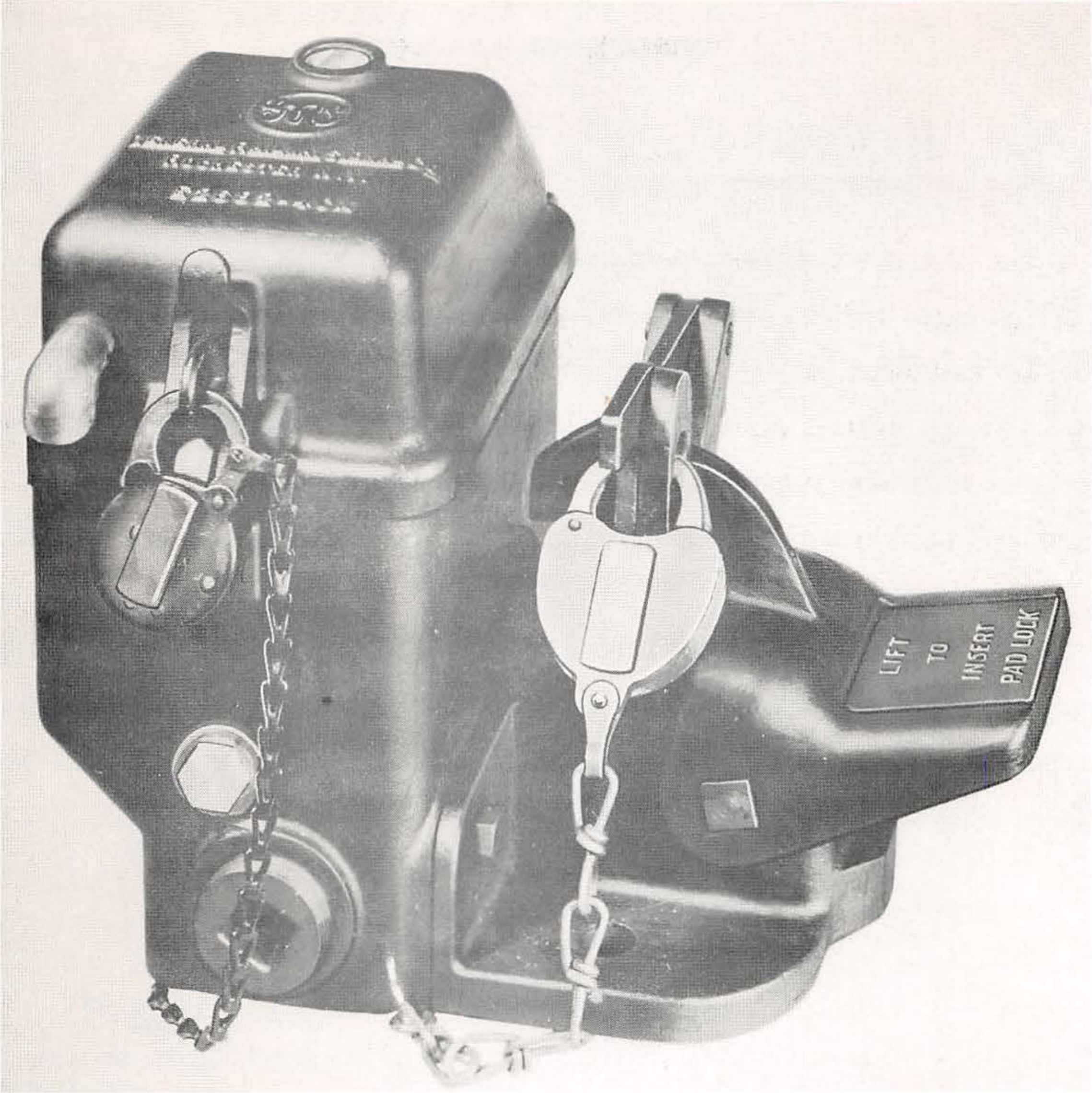


Figure 1. Model 10 electric switch lock, for use on low switch stands, shown in the fully locked position.

II. WHAT THE MODEL 10 SWITCH LOCK DOES

The Model 10 lock locks the hand-throw lever of the switch stand in the normal position. It permits the lever to be released and moved to the reverse position when the control circuit (automatic, semi-automatic, or manual, as desired) is energized (or when the emergency release is operated).

A. Automatic Release

For movements off a main track and on to a siding track, the lock may be arranged to permit the switch to be operated whenever the releasing track section is occupied. See Figure 21, page 26.

B. Cannot Lock Switch Reverse

Once the electric lock has been released and the switch hand-throw lever moved from its normal position, the electric lock cannot be locked up again until the hand-throw lever has been fully returned to its normal position.

C. Lamp Indicator

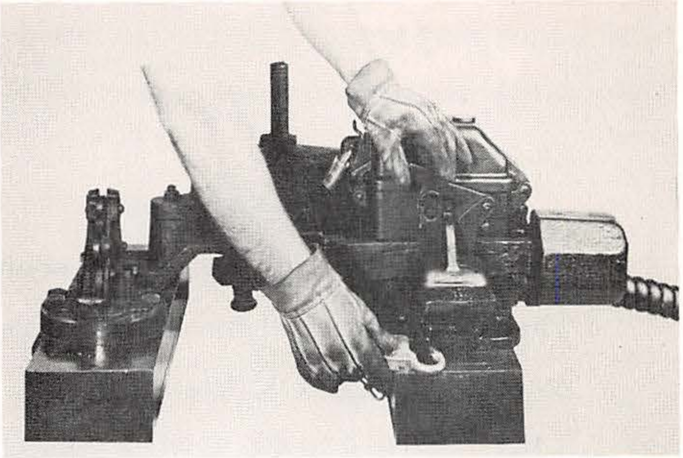
The lock magnets are normally deenergized. When they are energized by the control circuit and release the lock dog to permit the hand-throw lever to be operated, they also close a contact to light an indication lamp visible through the cover of the lock housing. The circuit may also be arranged to light the indication lamp simultaneously with energization of the control circuit.

D. Interlocked Emergency Release

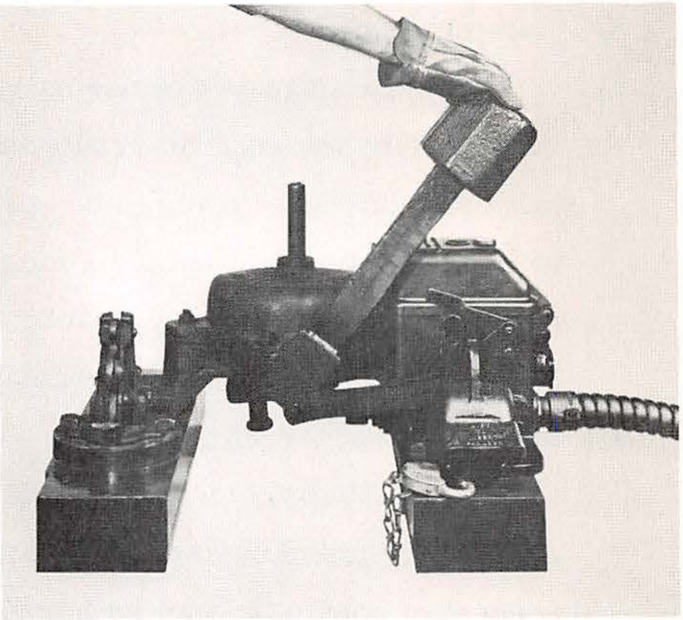
An interlocked emergency release (an optional feature) provides a means of unlocking the switch for emergency operation independent of control circuit authorization. The emergency release lever, which may be sealed if desired, does not become accessible for operation until the switch padlock has been removed and the preliminary release latch has been lifted. Operation of the emergency release may be arranged to set the associated signals at stop and to prevent their being cleared until the emergency release mechanism has been reset by a person having a key to the padlock which fastens the cover of the lock housing.

III. HOW TO OPERATE THE MODEL 10 SWITCH LOCK

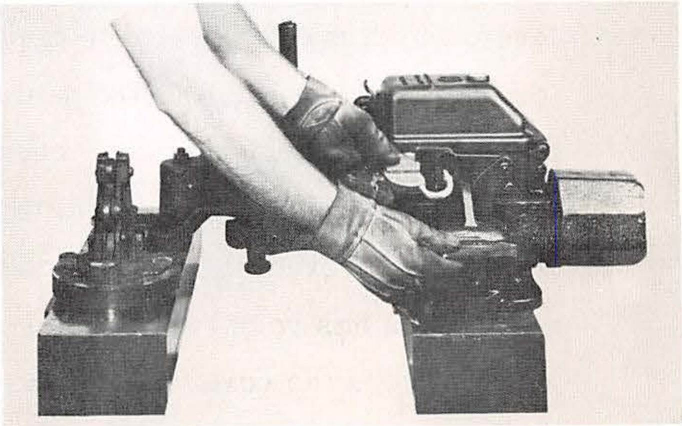
Remove the padlock and lift the latch.



If traffic conditions permit, the indication lamp will light. The switch may then be thrown to its reverse position.



After the switch has been returned to its normal position, lift the treadle. The latch will drop in place, and the padlock may then be replaced.



For operation of the emergency release, see page 11.

IV. OPERATIONAL SEQUENCE (NORMAL RELEASE)

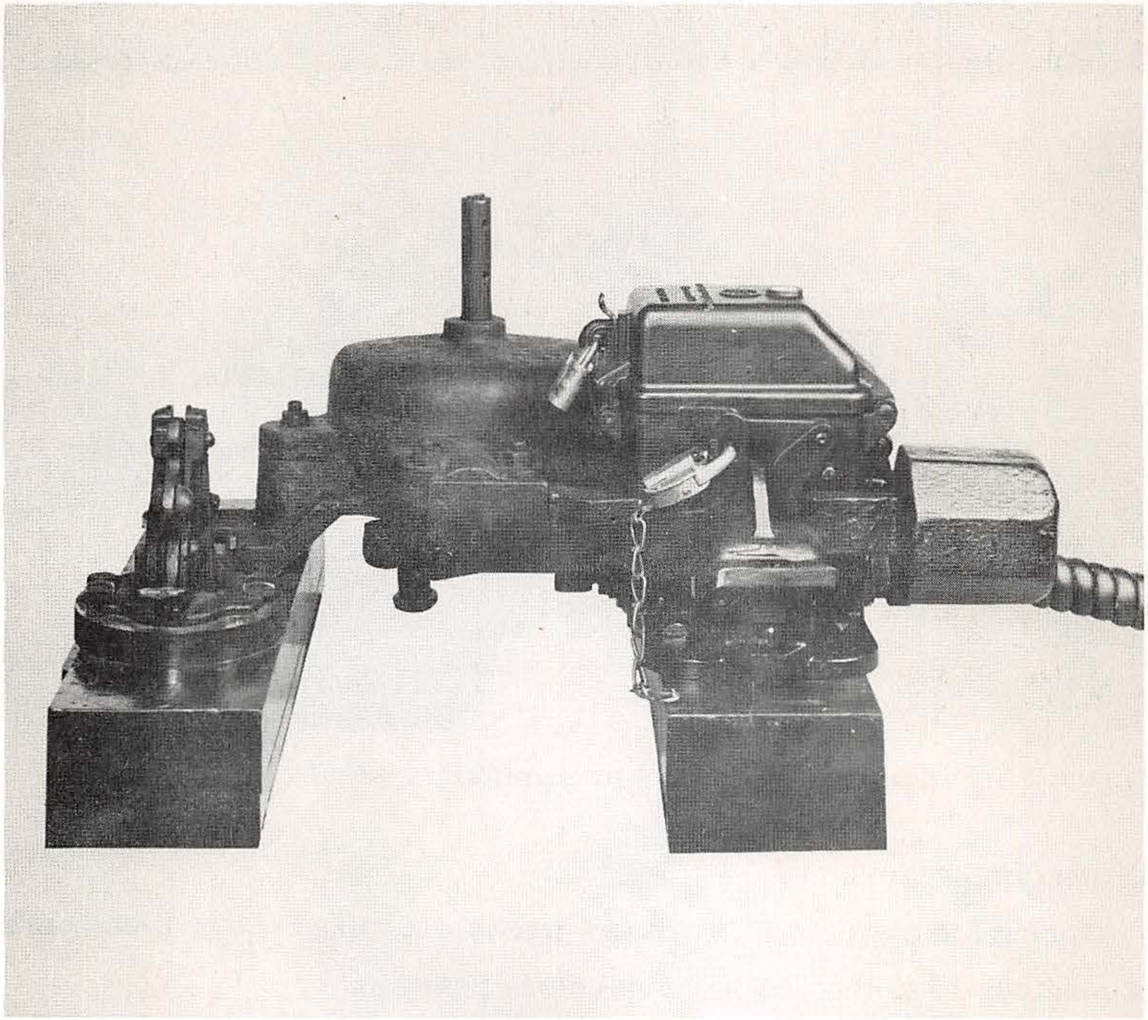


Figure 2. Locked in normal position.

Starting with the switch locked in its normal position, as shown in Figure 2, the following text and illustrations will describe, step by step, the operation of the lock by the trainman, and the resulting action of the mechanism. Unfold the insert, Figure 15, page 19, for references to the various parts of the mechanism.

Please note that the contacts and the wiring may be arranged differently from this typical example, if desired. See Figure 20, page 24.

Step 1. Remove padlock from hole 4 and lift preliminary release latch 2.

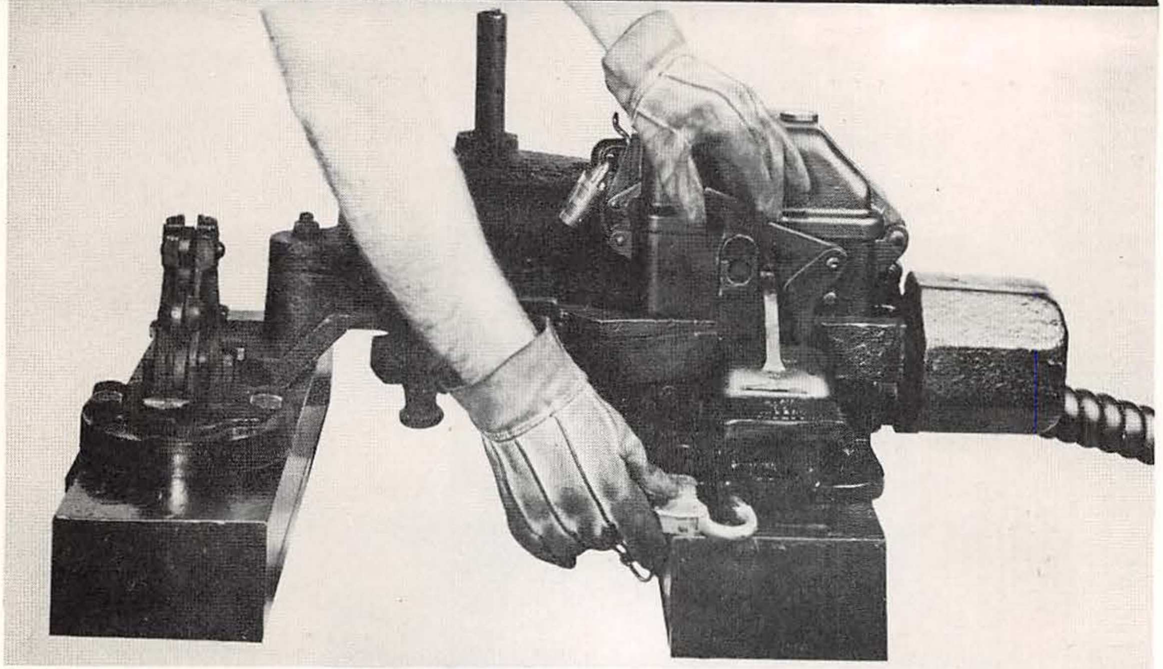


Figure 3. Padlock removed and preliminary release latch lifted.

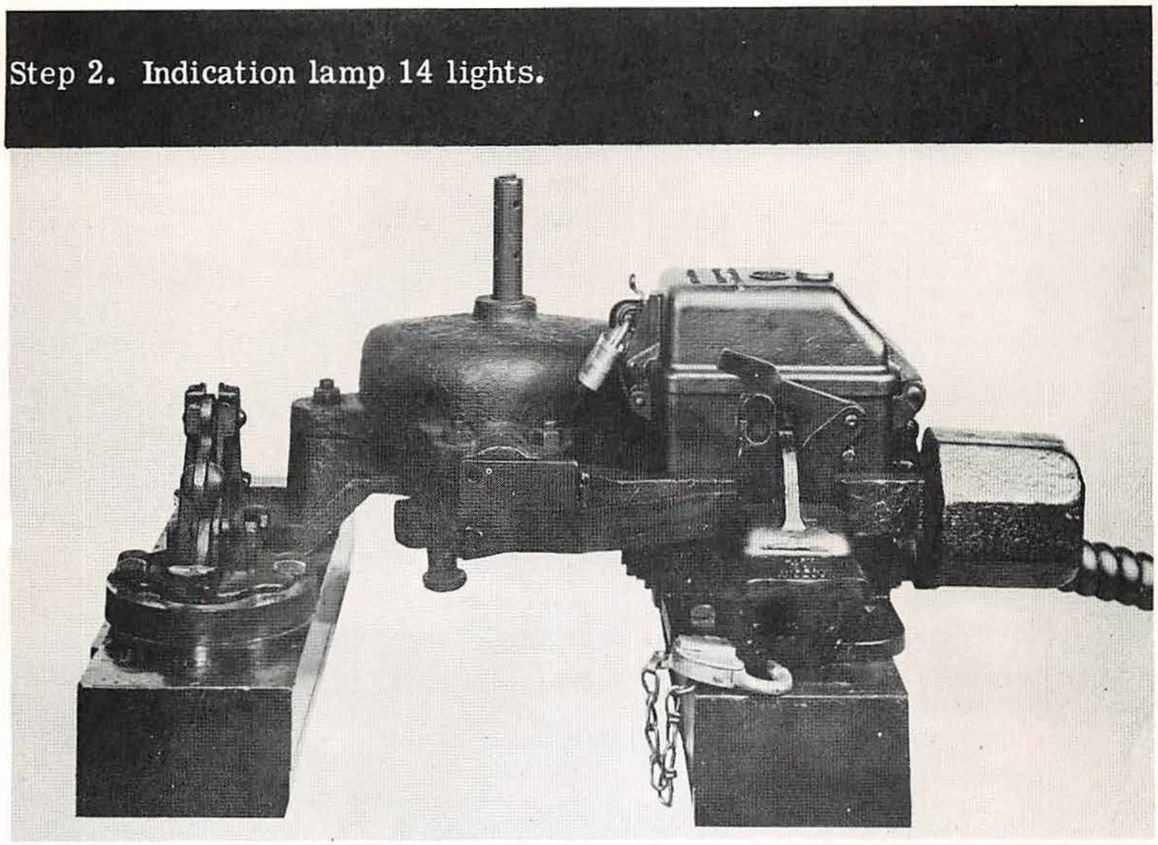
Action of mechanism—

Spring 6 moves shaft 8 forward, partly dropping treadle 5 and partly raising dog 10 to the preliminary unlock position.

As shaft 8 moves forward, it turns shaft 9 and attached quadrant 26. Arm 17 is forced up by lobe 20 of quadrant 26. The movement of quadrant 26 is limited by the engaging of armature arm 19 with step 21 cut in quadrant 26.

As arm 17 rises, it tilts attached plate 12 which carries the fingers of contacts 2B, 3F, and 4B. Thus contacts 2B and 4B are opened, and contact 3F is closed.

With contact 3F closed, a circuit is completed from the control circuit through lock coils 16. See internal wiring diagram accompanying Figure 15.



Step 2. Indication lamp 14 lights.

Figure 4. Lamp lighted, thus indicating unlock.

Action of mechanism—

If conditions are such that the control circuit is energized, armature 11 will be attracted to the pole faces of coils 16, and will raise its attached arm 19 out of step 21 in quadrant 26.

With quadrant 26 thus unlocked, lock dog 10 is free to move back out of the way when hand-throw lever 7 is raised.

When armature 11 is attracted to the pole faces of lock coils 16, it also moves attached fingers of contacts 1F and 5B, opening contact 5B and closing contact 1F. When contact 1F closes, indication lamp 14 is lighted. The circuit may also be arranged so that indication lamp 14 is lighted as soon as energy for coils 16 is received through contact 3F.

Step 3. Move hand-throw lever to reverse position.

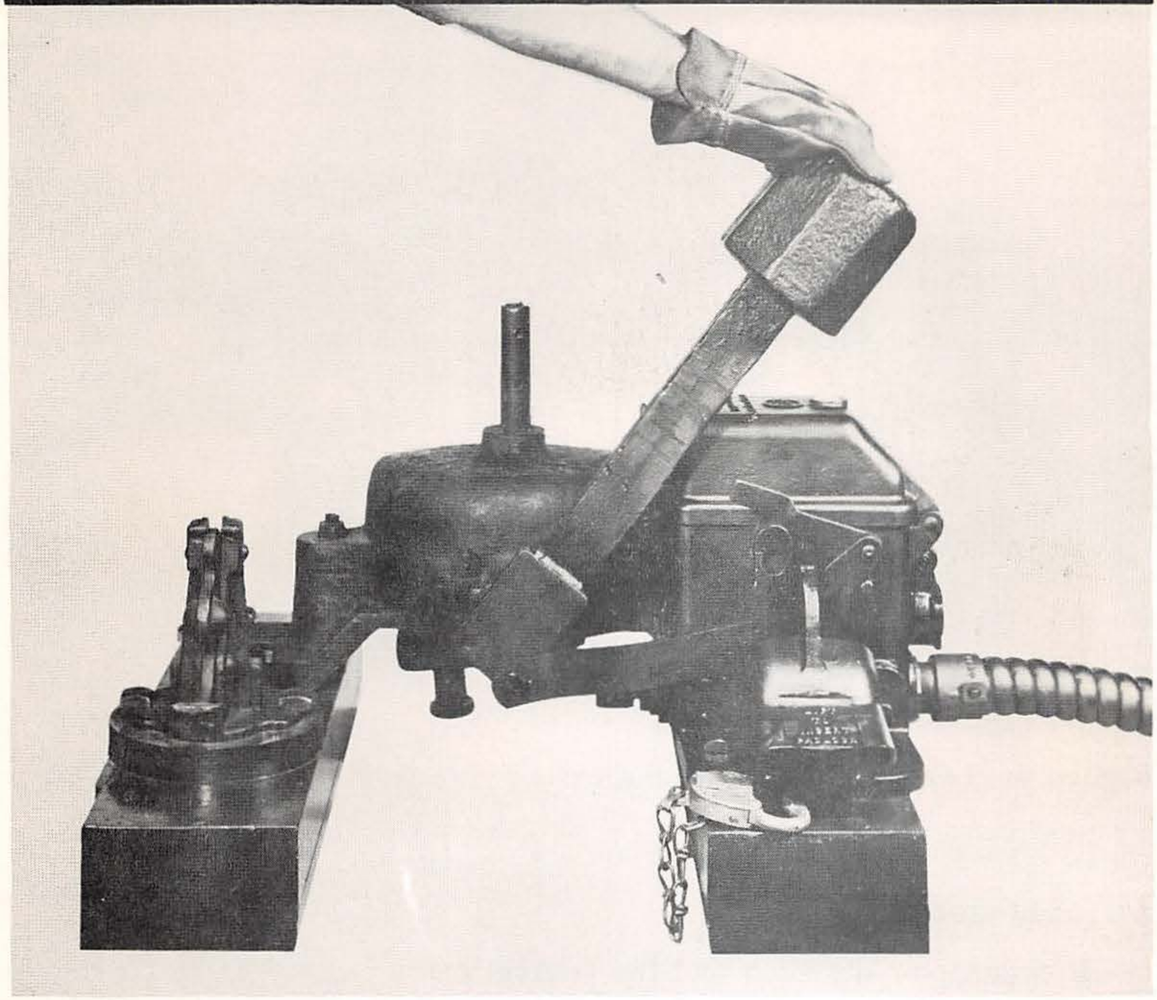


Figure 5. Moving hand-throw lever reverse.

Action of mechanism—

Lighting of lamp 14 indicates that hand-throw lever 7 may be lifted and moved to its reverse position. As lever 7 is lifted, it forces lock dog 10 to tilt out of the way, and rod 1 moves in and holds the lock dog in that position, thus preventing the mechanism from being locked up until the switch has been restored to its normal position.

Step 4. Return hand-throw lever to normal position.

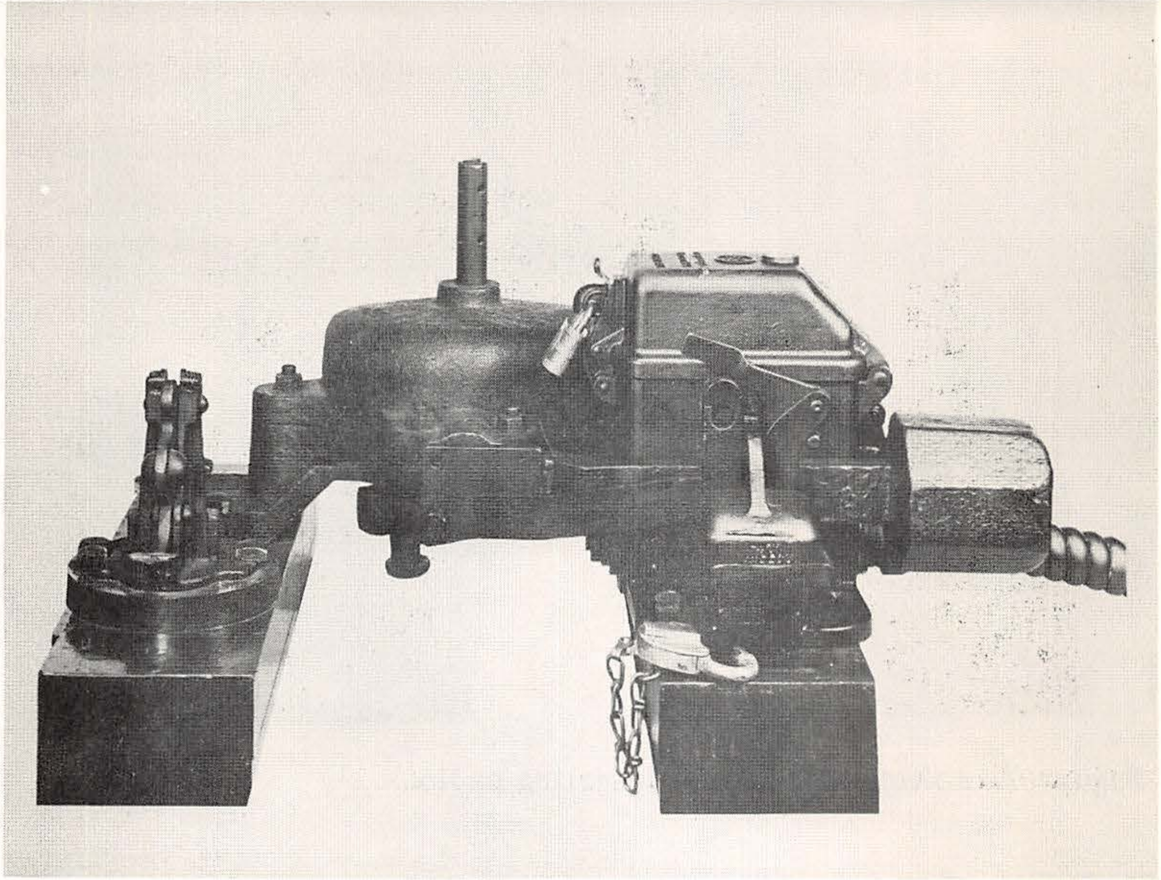


Figure 6. Hand-throw lever in normal position, but not yet relocked.

Action of mechanism —

As hand-throw lever 7 is returned to its normal position, rod 1 moves out from under lock dog 10, and the lock dog assumes its preliminary unlock position over lever 7.

Step 5. Lift treadle and reinsert padlock.

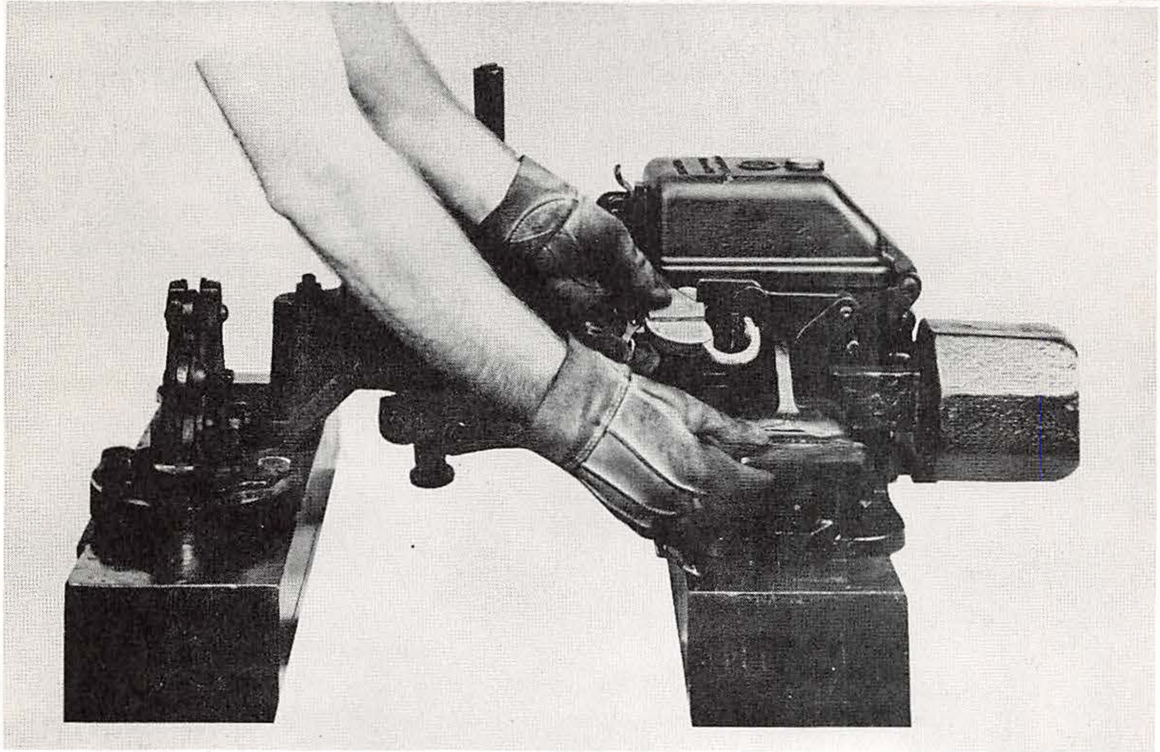


Figure 7. Lifting treadle and inserting padlock.

Action of mechanism—

Lifting treadle 5 moves quadrant 26 back to its normal locked position. Arm 17, forced down by spring 15, rides down on lobe 20; and armature arm 19 is forced back into step 21 on quadrant 26 by projecting spur 18 and spring 13.

All contacts are thus forcibly returned to and held in their normal positions as shown in Figure 15. Lock coils 16 are deenergized by the forced opening of contact 3F, and indication lamp 14 is extinguished by the forced opening of contact 1F.

Preliminary release latch 2 drops by its own weight between the step on dog 10 and part 3. The padlock may now be reinserted in hole 4.

V. OPERATIONAL SEQUENCE (EMERGENCY RELEASE)

Assuming that the normal control circuit does not respond and that the switch must be unlocked and operated for emergency reasons, the emergency release (an optional feature) would be used.

Starting with the switch locked in its normal position, the operation of the lock by the trainman and the resulting action of the mechanism would be as follows:

Step 1. Remove padlock from hole 4 and lift preliminary release latch 2.

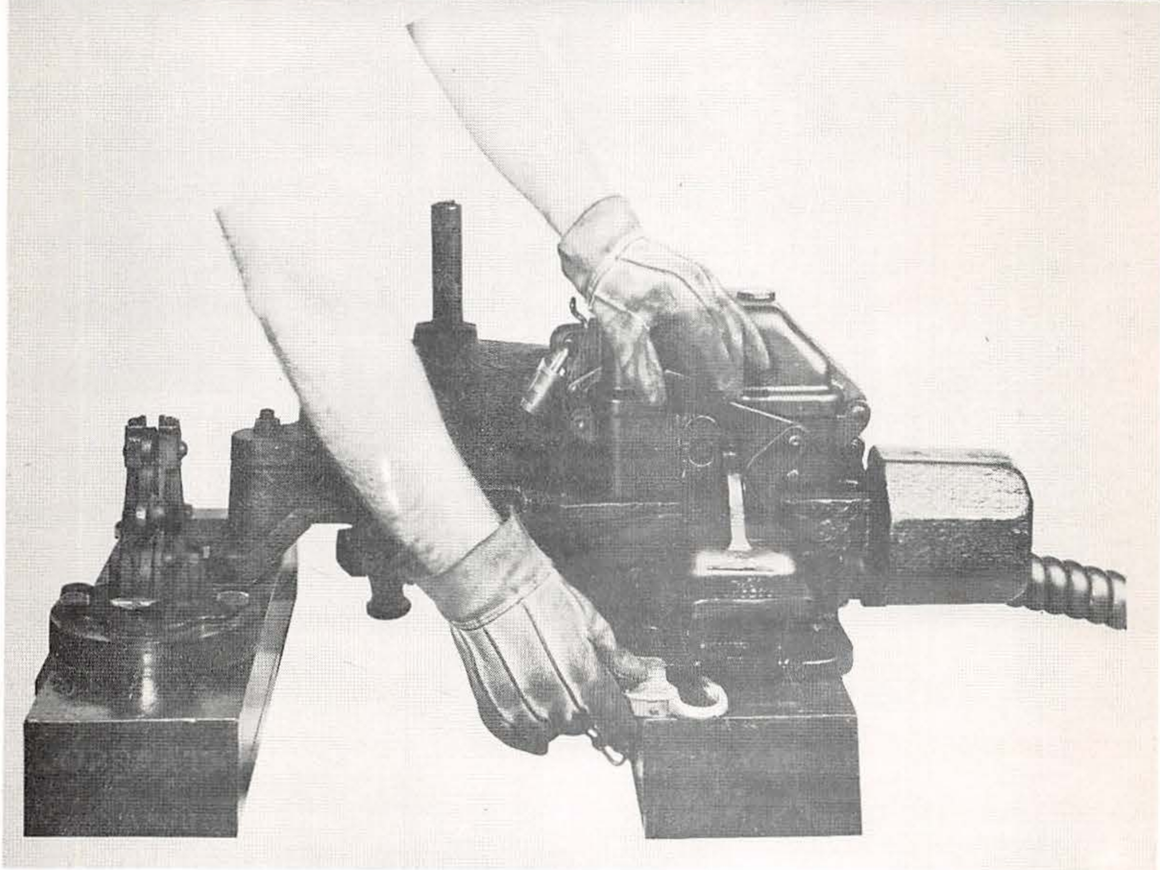


Figure 8. Padlock removed and preliminary release latch lifted.

Action of mechanism —

Same as described under Step 1 on page 6.

Step 2. Raise emergency release cover 24.

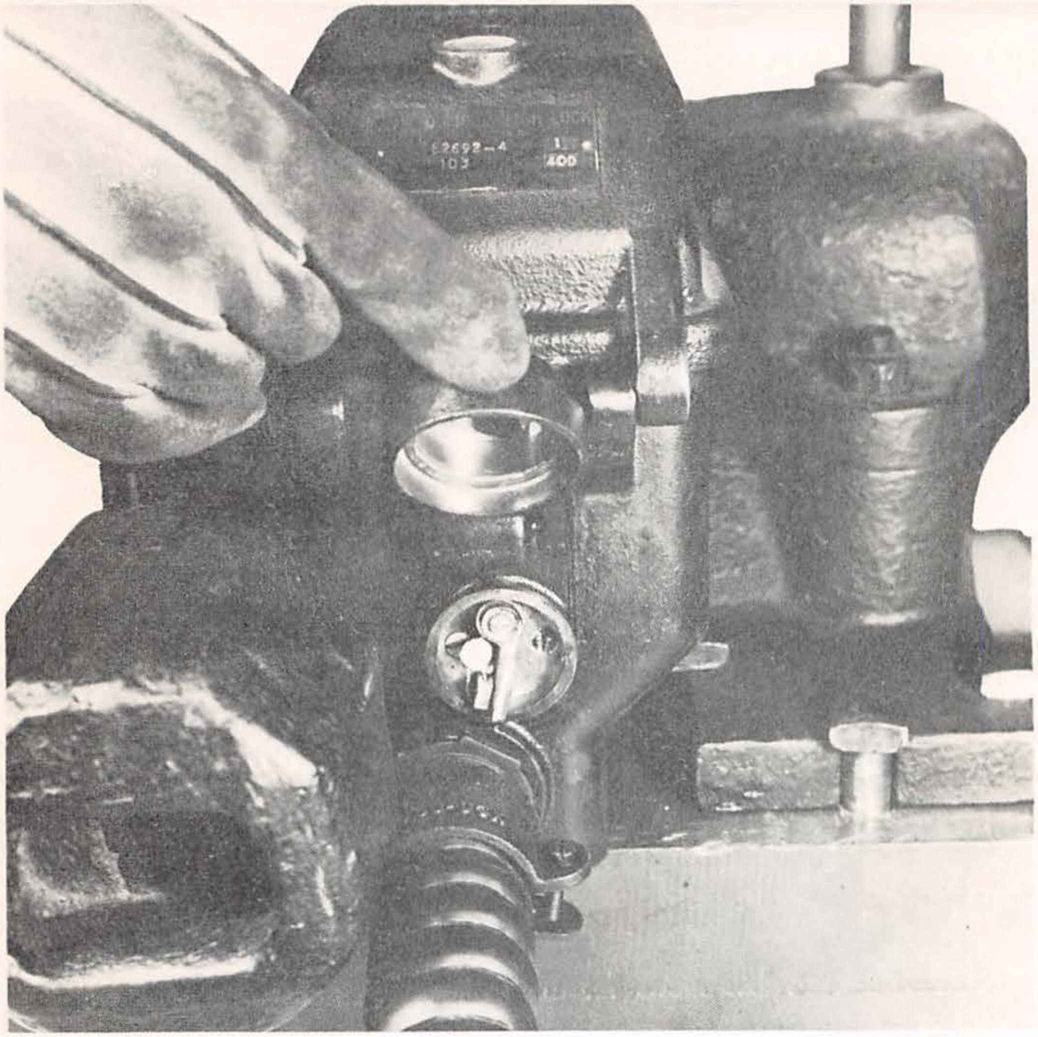


Figure 9. Raising emergency release cover.

Action of mechanism —

Note that cover 24 cannot be raised until Step 1 has been completed, as quadrant 26 must be moved forward to a point where rod 25 can enter slot 23 to allow cover 24 to be raised. Cover 24 remains up unsupported.

Step 3. Remove seal 30 and turn emergency release lever 29.

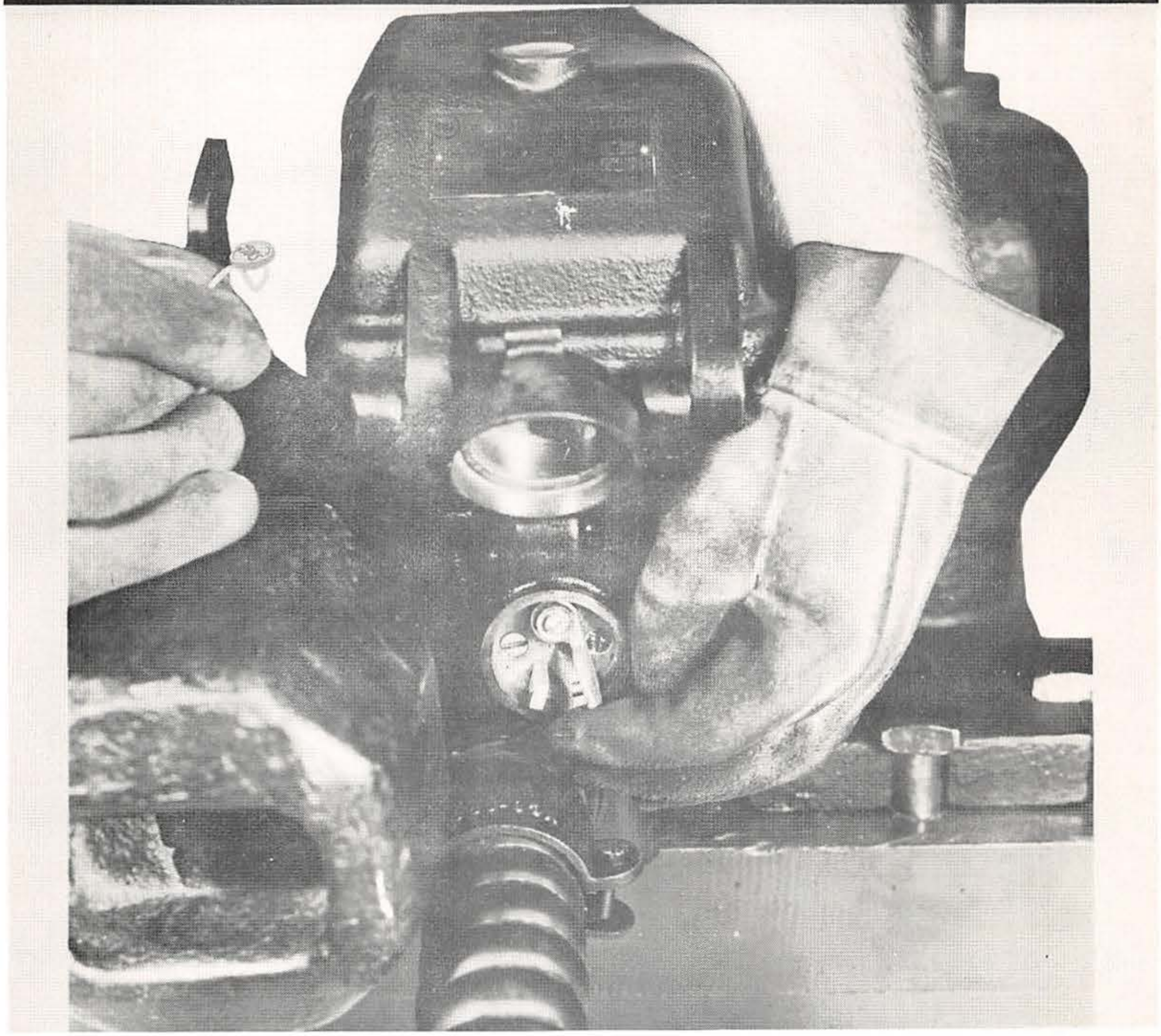


Figure 10. Seal removed and emergency release lever turned.

Action of mechanism—

Turning emergency release lever 29 in a counterclockwise arc, until its movement is stopped by flange 27, moves attached latch 22 under arms 17 and 19, lifting arm 19 and positioning the contacts just as though the lock coils had been energized by the control circuit. Arm 17 has already been raised by the action of the mechanism in Step 1, page 11.

Step 4. Move hand-throw lever to reverse position.

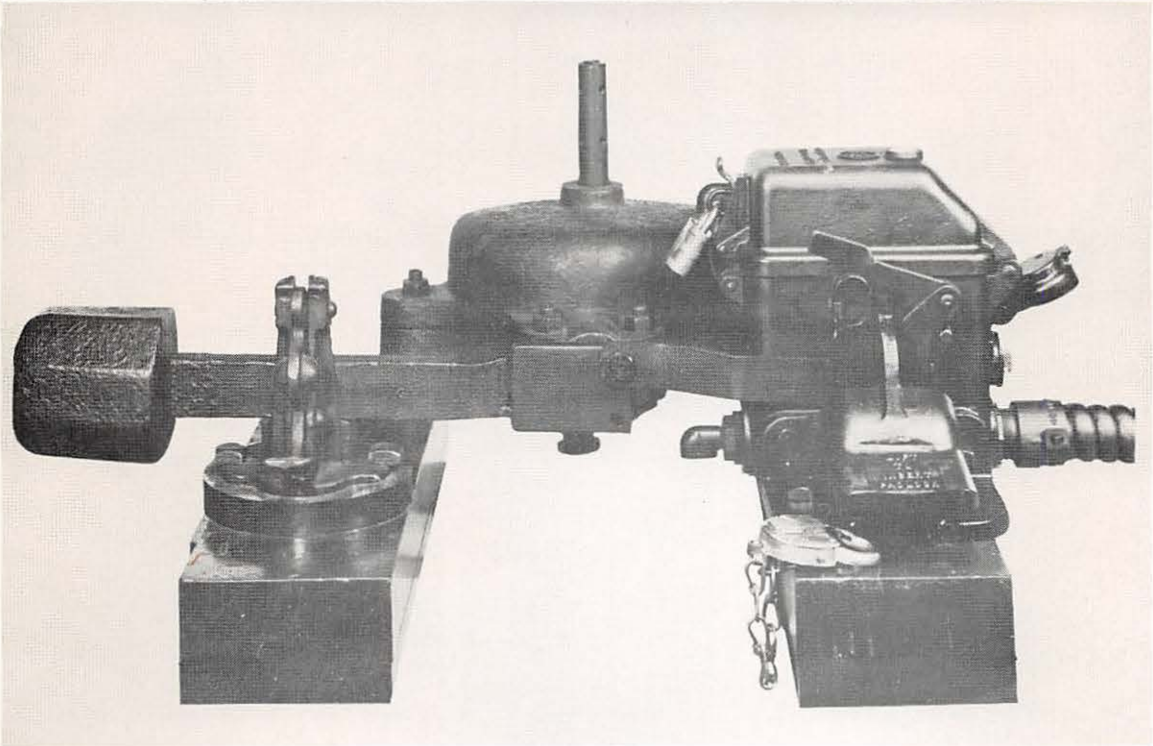


Figure 11. Hand-throw lever positioned reverse.

Action of mechanism—

As lever 7 is lifted, it forces dog 10 to move back out of the way. Dog 10 is free to move because armature arm 19 is raised out of step 21 in quadrant 26, thus leaving shaft 9 free to rotate as dog 10 moves shaft 8 forward. As lever 7 is lifted, rod 1 moves in and holds dog 10 in the unlocked position, thus preventing the mechanism from being locked up until the switch has been restored to the normal position.

Step 5. Return hand-throw lever to the normal position and close the emergency release cover 24.

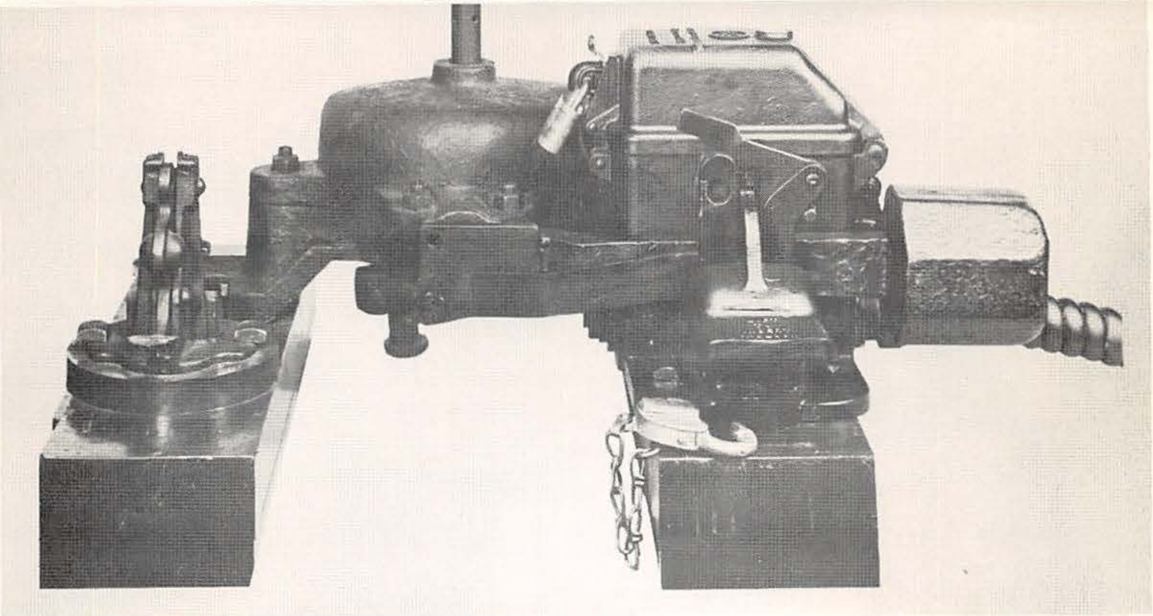


Figure 12. Hand-throw lever restored to the normal position and emergency release cover closed.

Action of mechanism —

Closing emergency release cover 24 withdraws shaft 25 from slot 23 in quadrant 26, thus permitting quadrant 26 to be returned to its normal locked position when treadle 5 is lifted.

As emergency release cover 24 is closed, projecting cam surface 28 on the inside of the cover engages emergency release lever 29, turning it so that attached latch 22 moves out from under armature arm 19. Spring 13 forces armature arm 19 down into its normal locked position on quadrant 26. As armature arm 19 assumes its locked position, it causes contact 1F to open and 5B to close — their normal positions.

The step cut in latch 22 engages arm 17, keeping it up and holding contacts 2B, 3F, and 4B in the "unlock" position until such time as the mechanism case is opened and arm 17 is lifted by hand to allow latch 22 to drop back.

Step 6. Lift treadle and reinsert padlock.

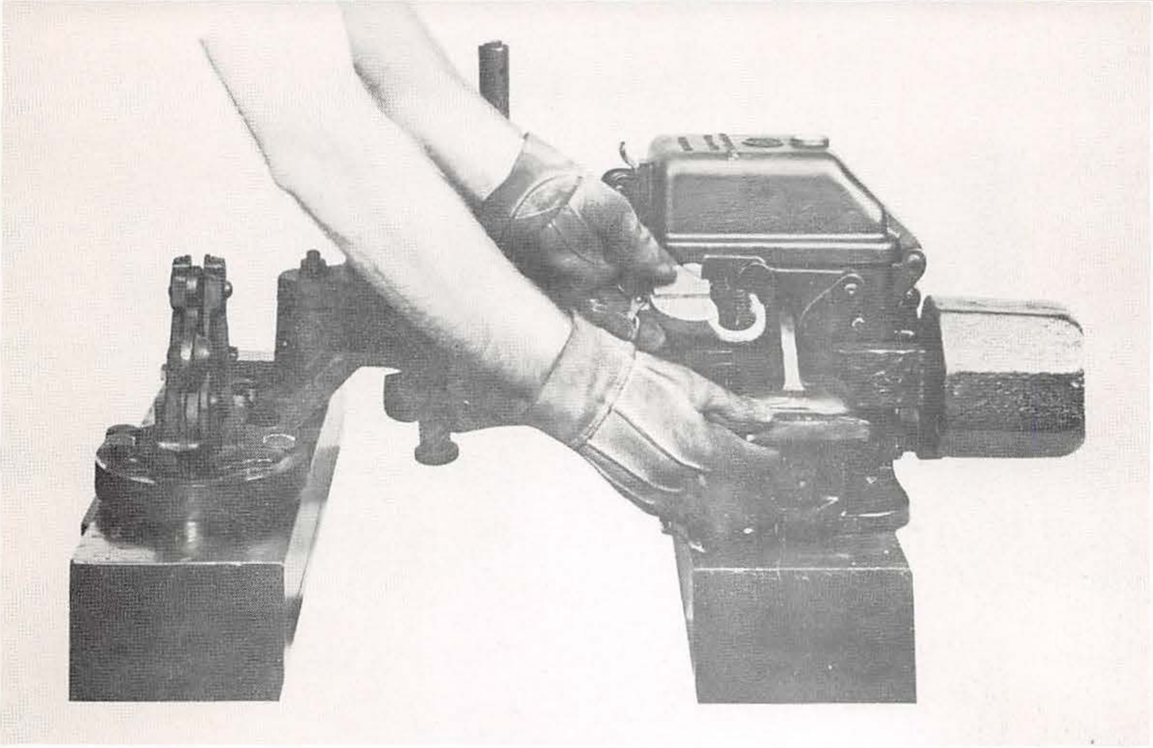


Figure 13. Lifting treadle and inserting padlock.

Action of mechanism —

Lifting treadle 5 allows preliminary release latch 2 to drop back in place and also moves quadrant 26 fully back to its normal position.

Note that latch 22 continues to hold up arm 17, and that contacts 2B and 4B remain open and contact 3F remains closed.

Step 7. Remove housing padlock, open housing, and reset the emergency release.

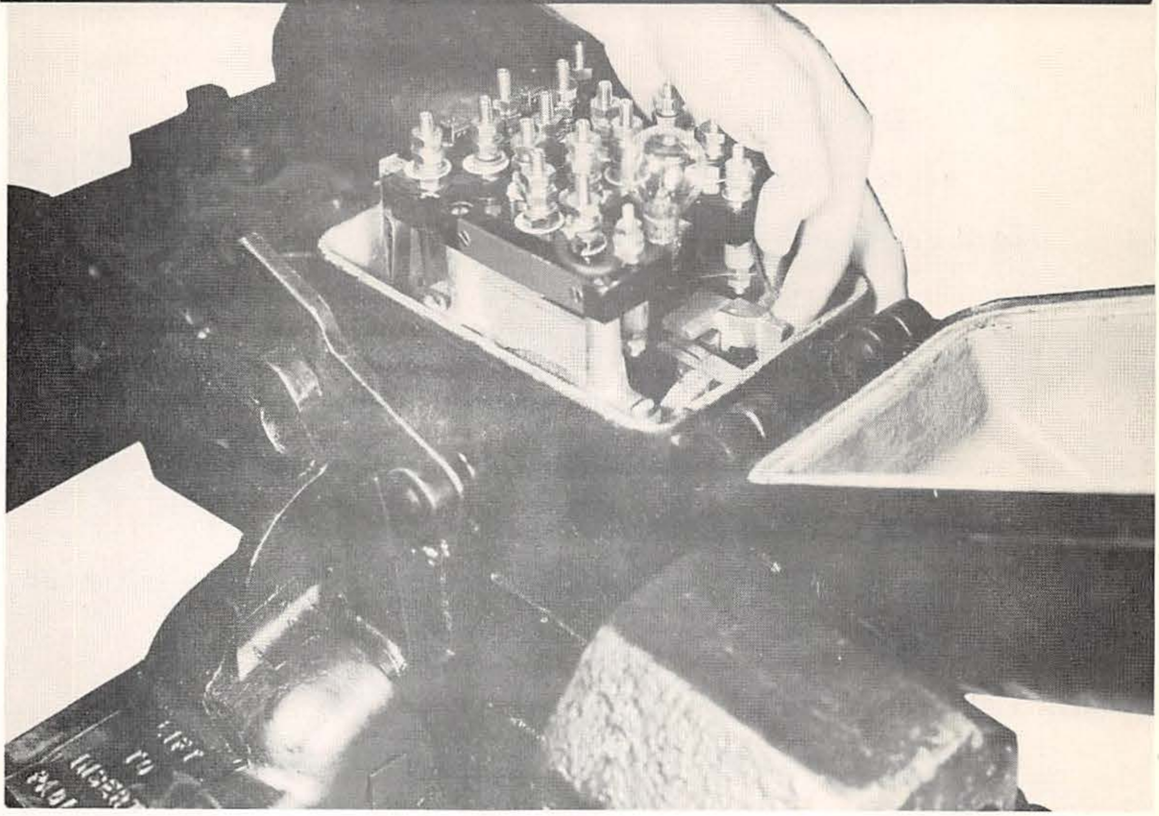


Figure 14. Mechanism case opened and emergency release mechanism restored to normal position.

Action of mechanism—

Lifting arm 17 allows latch 22 to drop fully back to its normal position. When arm 17 is released, spring 15 returns it to its normal position as shown in Figure 15, page 19. Contacts 2B and 4B close, and contact 3F opens.

After preliminary release latch 2 has been lifted, emergency release cover 24 may be opened and emergency release lever 29 resealed. The lock may then be restored to its normal locked condition.

VI. PHYSICAL DATA

A. Dimensions

Height	11-3/8 inches
Width	12-3/4 inches
Depth	14-1/4 inches

Accommodates low switch stand hand-throw levers from 3/4 by 2 inches to 1 by 2 inches.

B. Installation

Can be adapted to most low switch stands in common use, with or without lock rods. Figure 18 shows a typical installation.

The conduit entrance fitting attaches to either end. Entrance holes are 1-1/2 inch pipe tap.

The same lock may be used on a right-hand or a left-hand switch layout.

C. Lubrication

Figure 19 shows the location of the lubrication fittings. The lock should be lubricated at these points three or four times a year with a grease that will not thicken at low temperatures nor liquefy at summer temperatures. Greases which meet the Army-Navy specification AN-G-3A will meet the above requirements and are recommended.

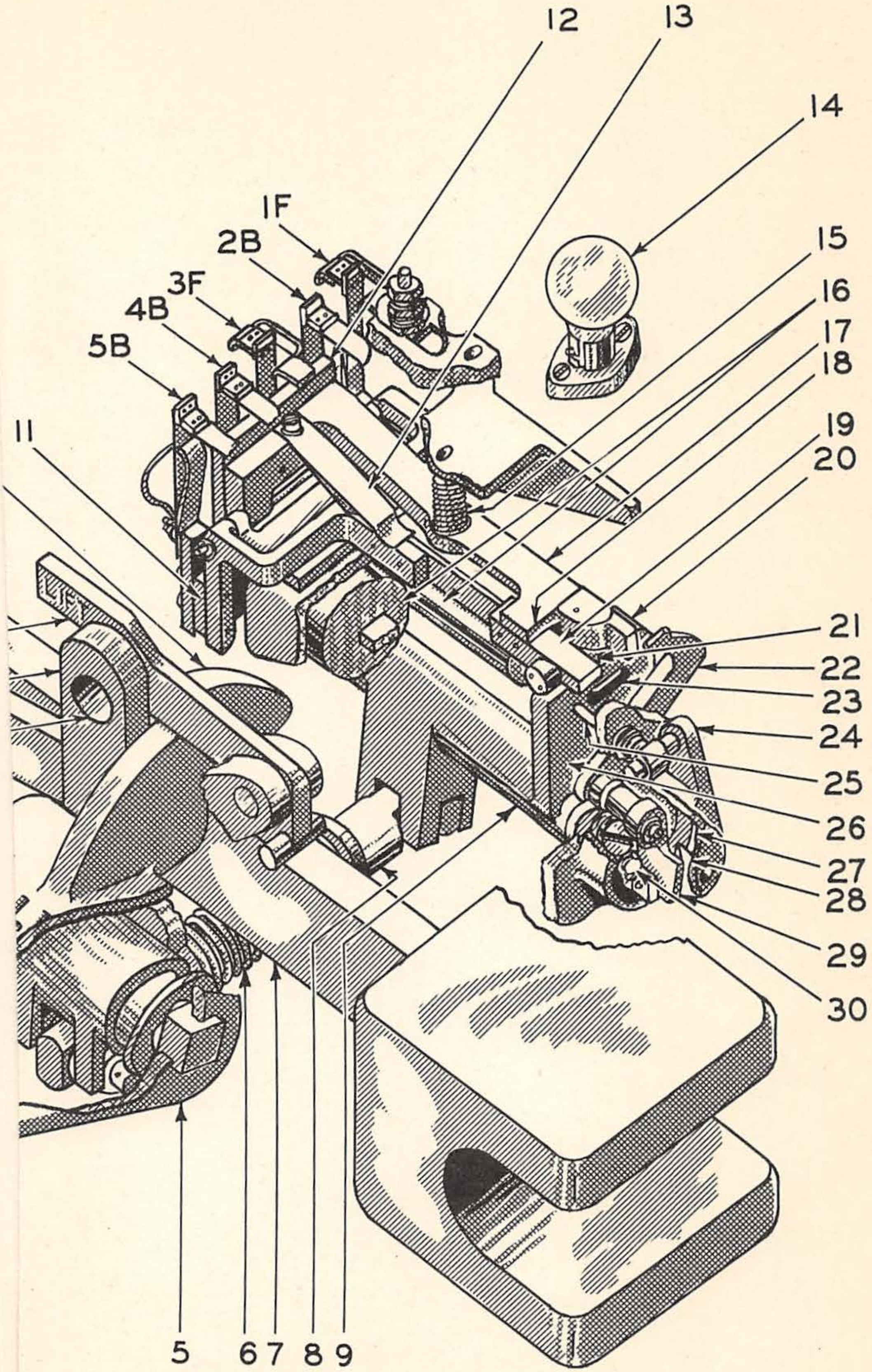

12
13
14
1F
2B
3F
4B
5B
15
16
17
18
19
20
11
21
22
23
24
25
26
27
28
29
30
5
6
7
8
9

Figure 15. Operating parts of Model 10 switch lock as applied to low switch stand, shown locked in normal position

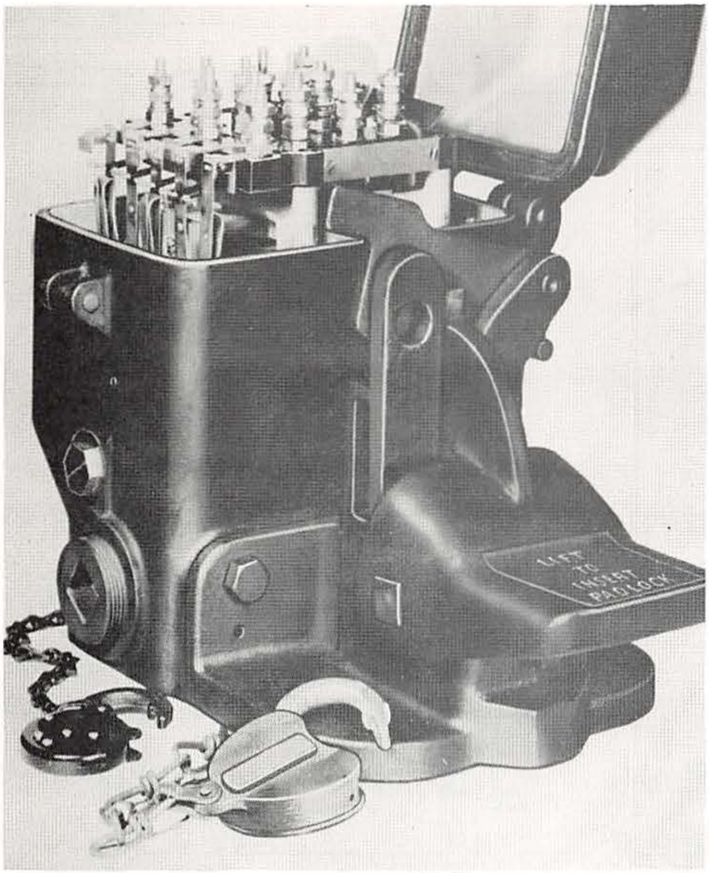


Figure 16. Contacts are readily accessible when cover of housing is raised.

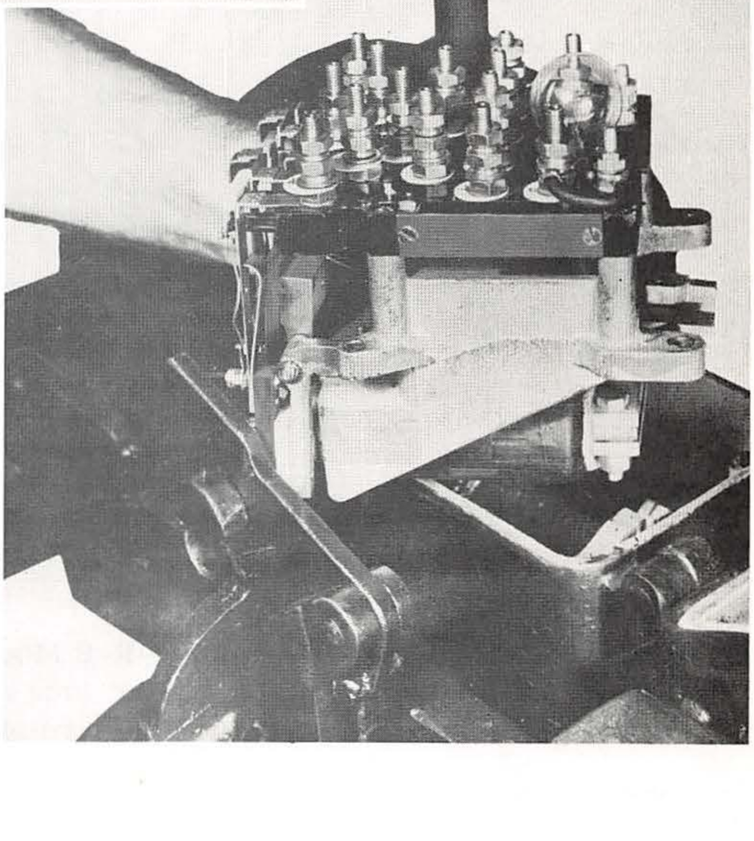


Figure 17. The entire mechanism can be removed from the housing by disconnecting the wiring and removing four screws.

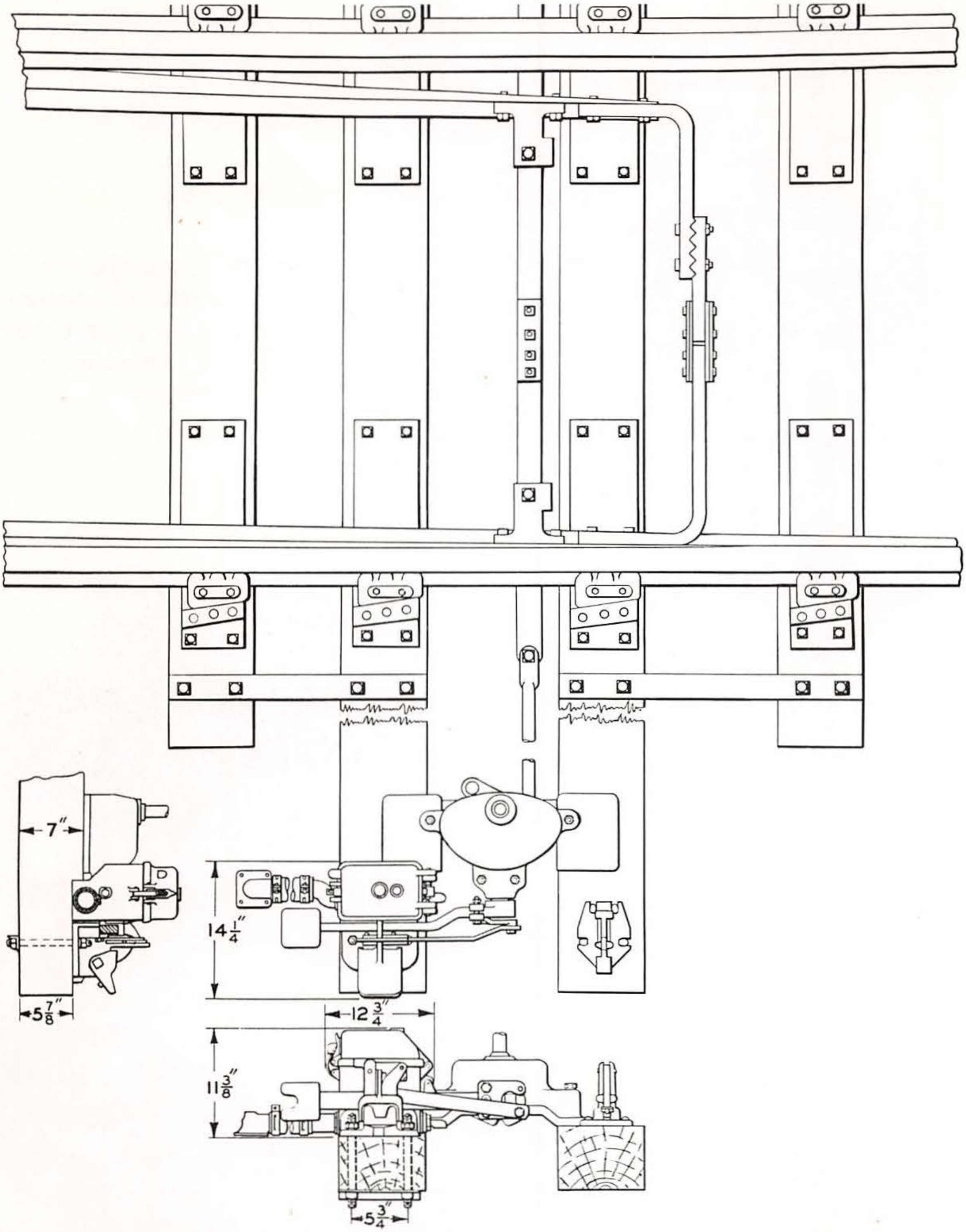

7"
$5\frac{7}{8}$"
$14\frac{1}{4}$"
$12\frac{3}{4}$"
$11\frac{3}{8}$"
$5\frac{3}{4}$"

Figure 18. Typical installation of G-R-S Model 10 electric switch lock on low switch stand without lock rod. Unless ordered otherwise, all necessary fittings are supplied to adapt the lock to the switch stand specified.

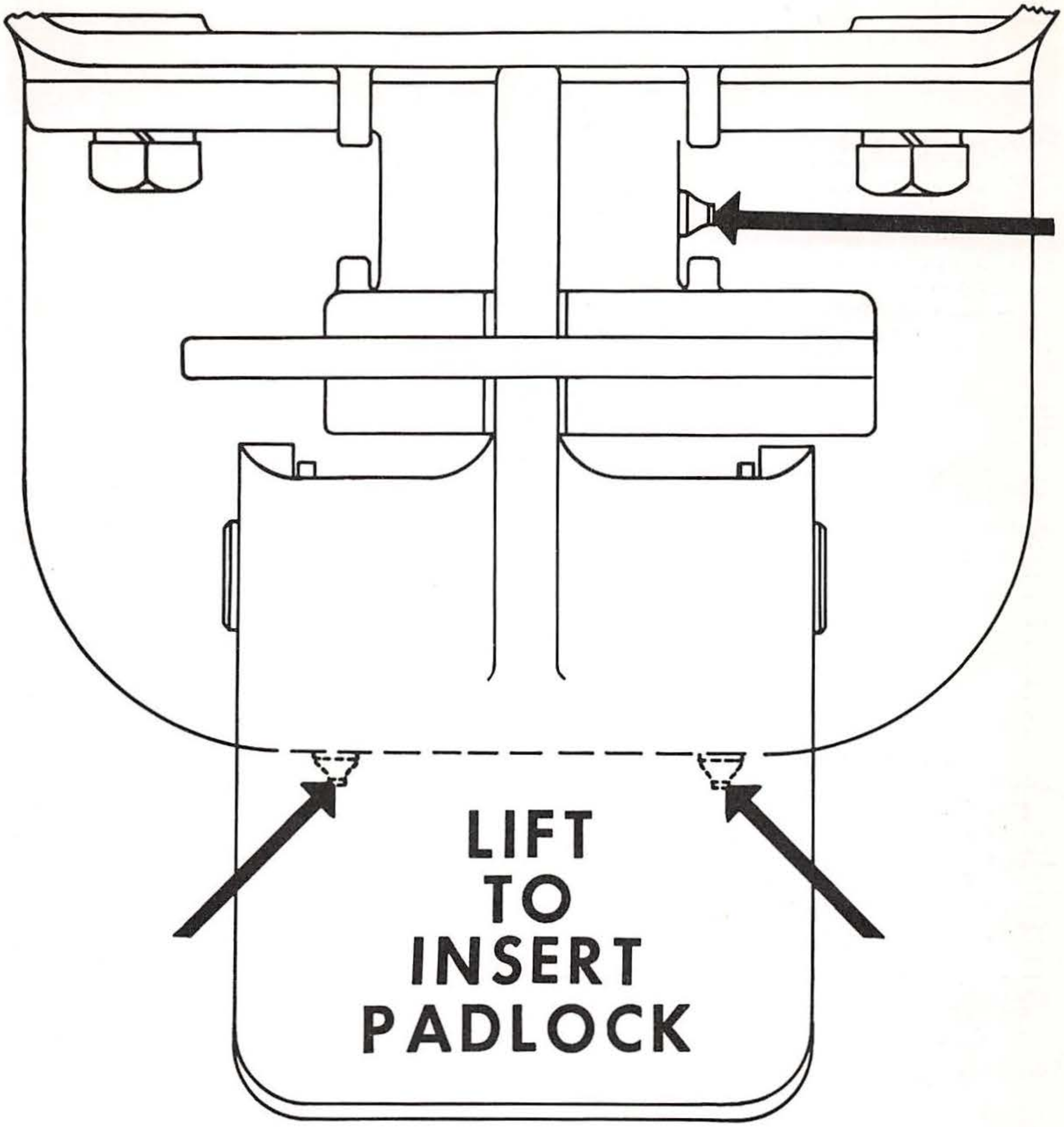
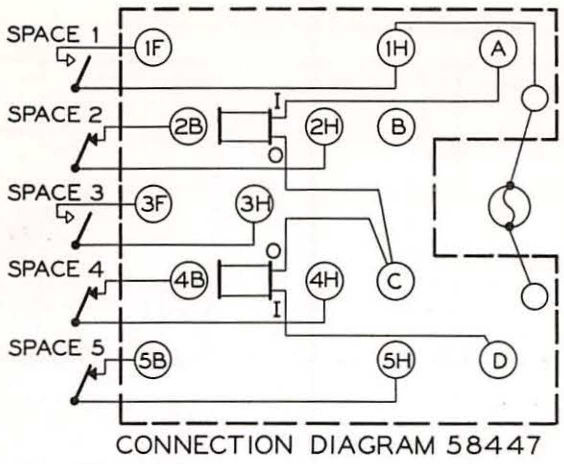


Figure 19. The lubrication fittings are indicated by arrows.

VII.ELECTRICAL DATA

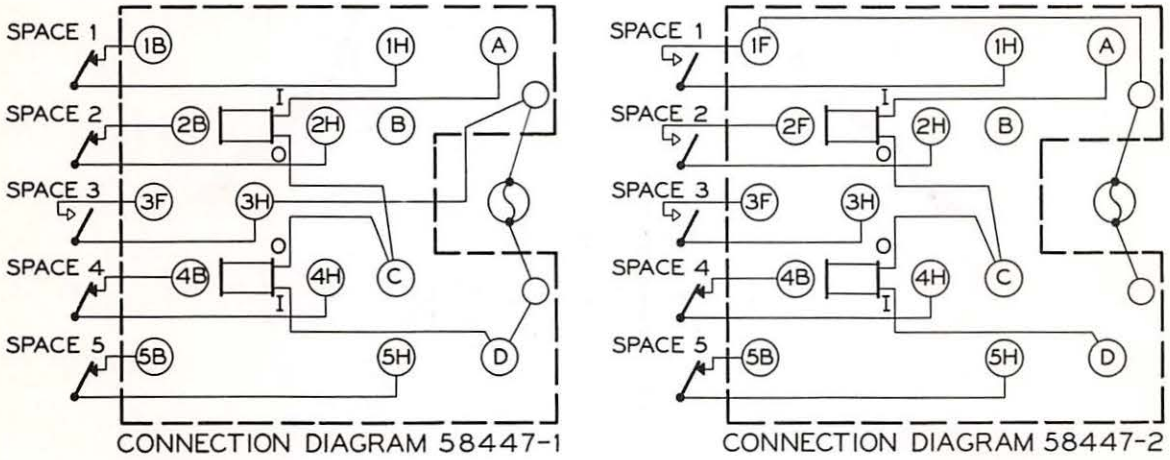
The Model 10 switch lock is designed for d-c. operation. It may be adapted to a-c. operation by providing a transformer and rectifier in an adjacent relay case.

NOTE: Contacts in spaces 1 and 5 are actuated by energization of the lock-magnet coils. Contacts in spaces 2, 3, and 4 are actuated whenever the preliminary release latch unlocks the treadle.


SPACE 1
SPACE 2
SPACE 3
SPACE 4
SPACE 5
1F
1H
A
2B
I
O
2H
B
3F
3H
C
4B
4H
D
5B
5H
CONNECTION DIAGRAM 58447

(a) Lock-magnet contacts -
one independent front and
one independent back.

Release-latch contacts -
one independent front and
two independent backs.


SPACE 1
SPACE 2
SPACE 3
SPACE 4
SPACE 5
1B
1H
A
2B
2H
B
3F
3H
C
4B
4H
D
5B
5H
I
O
CONNECTION DIAGRAM 58447-1
SPACE 1
SPACE 2
SPACE 3
SPACE 4
SPACE 5
1F
1H
A
2F
2H
B
3F
3H
C
4B
4H
D
5B
5H
I
O
CONNECTION DIAGRAM 58447-2

(b) Lock-magnet contacts -
two independent backs.

Release-latch contacts -
one independent front and
two independent backs.

(c) Lock-magnet contacts -
one independent front and
one independent back.

Release-latch contacts -
two independent fronts and
one independent back.

Figure 20. Typical connection diagrams showing binding post designations, internal wiring, and contact arrangements.

A. Contacts

There are 5 independent silver-to-silver contacts, 3 operated by the preliminary release latch and 2 by the lock coils. Any of these contacts may be supplied normally open or normally closed as desired.

Minimum contact pressure is 1-1/2 ounces.

B. Operating Values

Coils are available with operating values as follows (others can be supplied as requested):

Normal operating voltage: 10-12

Resistance of coil, in ohms: 400

Operating value of coils, in amperes: 0.018

Operating value of lamp, in amperes: 0.250

Coils are connected in series as shown in the connection diagrams in Figure 20, page 24. Either coil has sufficient strength to operate the lock.

C. Lamp

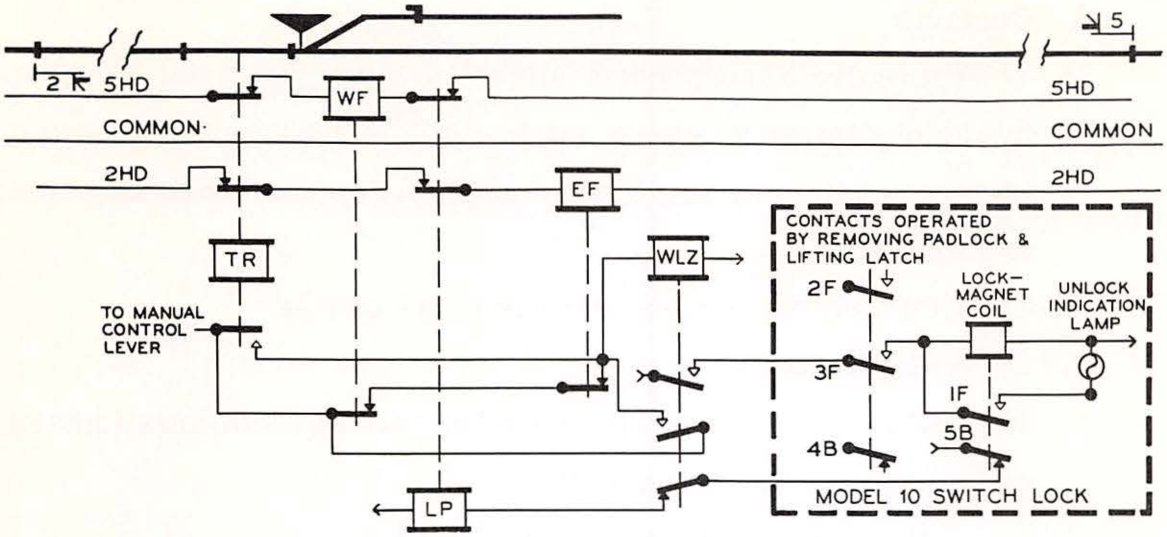
The lock is supplied with a single-contact candelabra base lamp, ordering number 34866-5.

D. Connection Diagrams

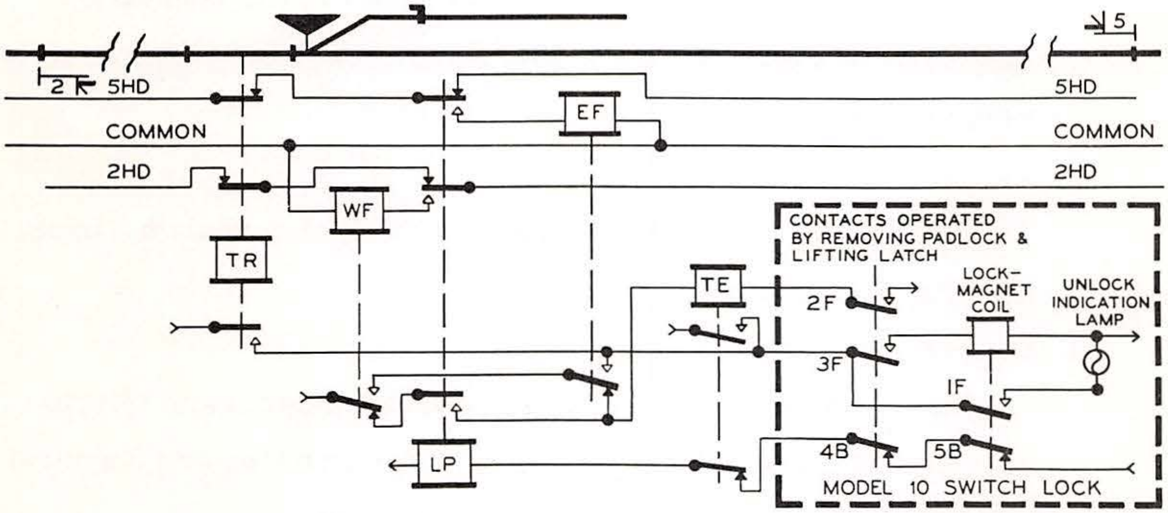
Locks are supplied with contact arrangements and internal connections as desired. Binding post designations and 3 typical connection diagrams are shown in Figure 20.

E. Typical Circuits

Figure 21, page 26, shows typical circuits for use of the Model 10 switch lock with absolute permissive block signaling.


2
5HD
COMMON
2HD
WF
EF
TR
WLZ
TO MANUAL CONTROL LEVER
CONTACTS OPERATED BY REMOVING PADLOCK & LIFTING LATCH
2F
3F
4B
LOCK-MAGNET COIL
UNLOCK INDICATION LAMP
1F
5B
LP
MODEL 10 SWITCH LOCK
5

(a) Circuit showing manual control to release the Model 10 lock. For lock connection diagram see Figure 20, diagram 58447-2.


2
5HD
COMMON
2HD
EF
WF
TR
TE
CONTACTS OPERATED BY REMOVING PADLOCK & LIFTING LATCH
2F
3F
1F
4B
5B
LOCK-MAGNET COIL
UNLOCK INDICATION LAMP
LP
MODEL 10 SWITCH LOCK
5

(b) Circuit showing automatic control to release the Model 10 lock. For lock connection diagram see Figure 20, diagram 58447-2.

Figure 21. Typical application circuits showing the Model 10 switch lock applied to absolute-permissive-block signaling.

VIII.SUMMARY OF ADVANTAGES

A. Ruggedly Compact

All external parts are substantially made of close-grained gray cast iron, finished inside and out with corrosion-resistant paint.

Internal mechanical and electrical parts may be securely locked with a separate padlock.

B. Simple

Both hands are left free to operate the switch lever.

Contacts are readily accessible.

Entire mechanism may be easily removed from housing by taking out 4 screws.

The external operative parts of the lock are no more susceptible to ice and snow interference than are the operative parts of an ordinary switch stand.

C. Efficient

Normally deenergized lock and lamp conserve energy.

The lock cannot be locked up until the switch is in its normal position.

Housing is weatherproof and may be provided with adequate rainproof ventilation, if desired.

All vital, internal moving parts are held securely in position by spring tension to minimize wear from vibration.

Locking mechanism and contacts operate on the forced-drop principle.

A resiliently mounted socket protects the indication lamp from vibration.

D. Flexible

The Model 10 switch lock may be applied to most low switch stands or hand-operated switch machines, with or without lock rods.

Conduit entrances and ventilators are interchangeable.

The lock may be controlled by any standard signaling circuit.

Any of the 5 dependent contacts may be normally open or normally closed, as desired.

The same lock can be used on a right-hand or a left-hand switch layout.

An interlocked emergency release is available as an optional feature. It may be sealed if desired.

All standard parts are interchangeable among different locks.

IX. ORDERING INFORMATION

When ordering a Model 10 switch lock, please supply the following information:

Type of switch stand (manufacturer's name and model number).

Supply voltage, whether a-c. or d-c.

Frequency (if a-c.).

If controlled directly over line, please state length of line and size of wire.

Which contacts are to be normally closed and which are to be normally open (see typical connection diagrams, Figure 20, page 24).

Whether emergency release feature is desired.

Unless otherwise ordered, G-R-S will supply all the necessary fittings to adapt the Model 10 lock to the particular switch stand specified.

* * *

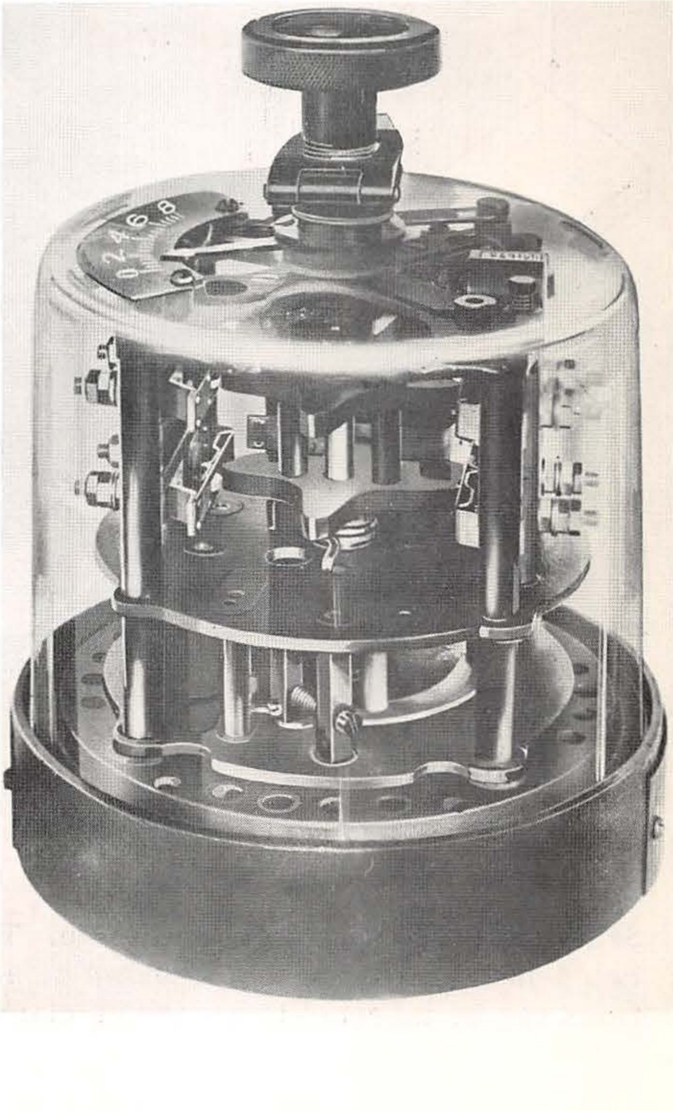
Eight-Minute Universal Clockwork Time Release

A new time release, with an adjusting range of eight minutes, has been added to the G-R-S line of universal clockwork time releases.

The increased time range is accomplished by loading down the pallet of the escapement mechanism, thereby slowing the movement.

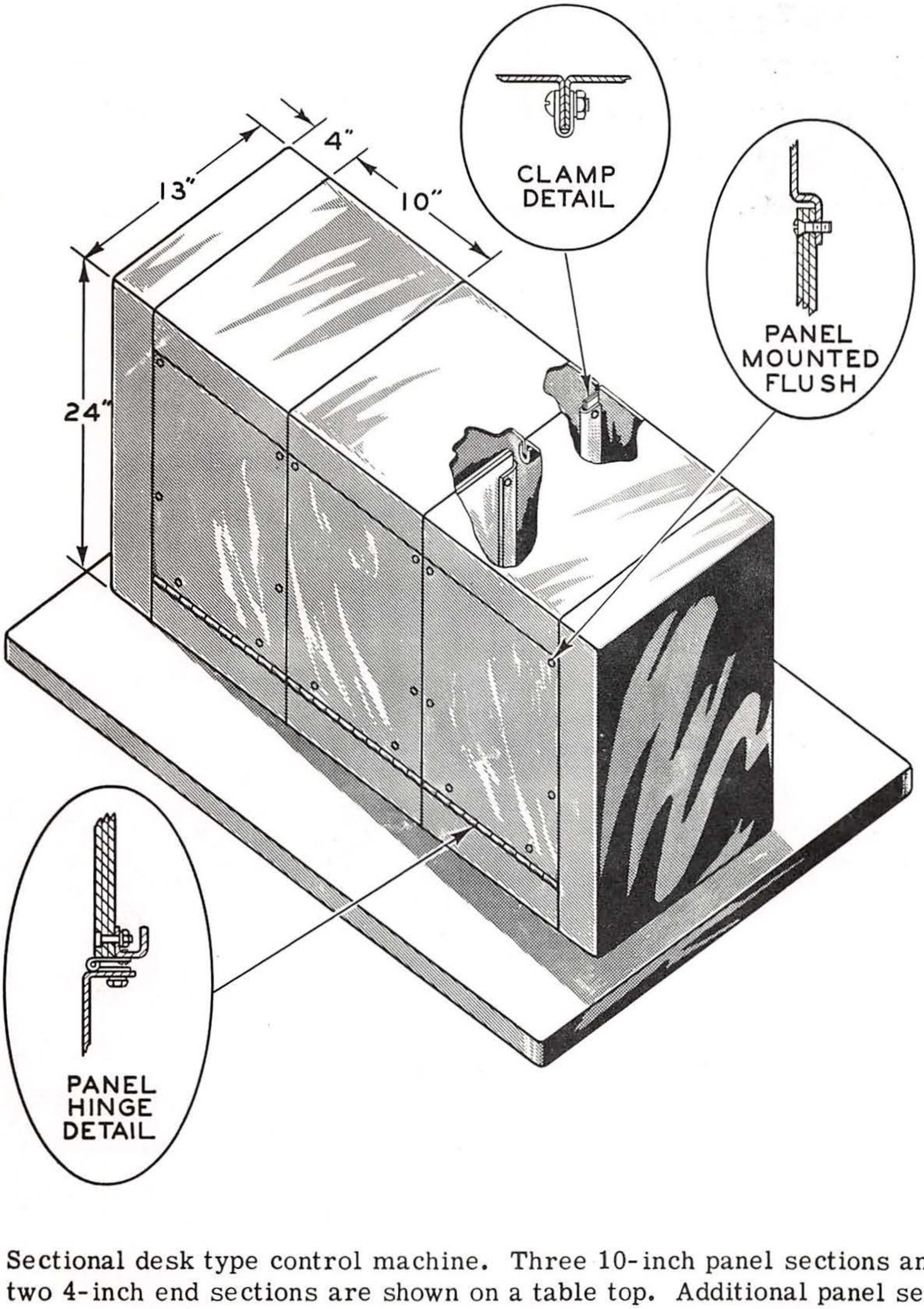
Except for the heavier pallet and a new dial, graduated from 0 to 8, this release is the same as the standard time releases supplied with maximum times of two, three, and four minutes.

* * *



Eight-minute clockwork time release (or contactor)

For details see Catalog Section K Part 5.


4"
13"
10"
24"
CLAMP DETAIL
PANEL MOUNTED FLUSH
PANEL HINGE DETAIL

Sectional desk type control machine. Three 10-inch panel sections and two 4-inch end sections are shown on a table top. Additional panel sections can be inserted by removing clamps between the sections.

Sectional Desk Type Control Machine

A new desk type control machine (59667) is being made on CM5285 for the Baltimore and Ohio. This new model meets the demand for a 55400 machine with an extension feature.

It is made up of two end sections and as many 10-inch panel sections as may be required. Additional panel sections may be added when necessary.

There is no provision made for locating relays within the machine. Relays are to be located in separate 10-inch sectionalized racks.

There are several advantages to this type of machine. It may be enlarged at any time by simply attaching the additional panel sections. Inasmuch as it does not house relays, it can be installed in a comparatively light structure, while the relay cases can be located where their weight can be safely sustained. It is also adapted to installation in a structure with inadequate fire protection, as the relays may be more safely located elsewhere.

Panels may be 3/16 or 1/4 inch, as required. Terminal boards can be provided so that the terminals are accessible either from the front or the back, just as in the case of desk-top control machine (55400) described in the October 1945 issue of G-R-S NEWS.

* * *

Birthdays Next Month

There follow the biographies of Messrs. Anderson, Brown, Charlton, Haigh, Price, Schwendt, Seaholm, and Webb, who celebrate their birthdays in July.

Ernest Wilhelm Anderson, signal and telephone engineer, Nashville Chattanooga and St. Louis with headquarters in Nashville, Tenn., was born in Heldingborg, Sweden, July 9, 1889. He was educated in Sweden, graduating from high school to enter the University of K.T.S. near Stockholm. He received his M.E. and master degree in mathematics in 1913.

Mr. Anderson served a machinist apprenticeship in Sweden from 1904 to 1908; was in the Swedish Army, Field Artillery, 1908-09. After graduating from the university he was employed for a year by a subsidiary of SKF Co. He entered railroad service in 1916 as signal draftsman on the U.P. at Omaha, Nebr. From 1918 to 1940 he was successively signal draftsman, designer, general signal inspector, general signal and telephone inspector, and acting signal and telephone engineer on the N.C. & St.L. On May 1, 1941 he became signal and telephone engineer. He is a member of the Signal Section, A.A.R.

Earl F. Brown, signal-electrical engineer, Pittsburgh and Lake Erie, with headquarters in Pittsburgh, Pa., was born July 8, 1902, in Duquesne, Pa. He received his B.S. degree in electrical engineering from Carnegie Institute of Technology in 1924, and entered service with the P. & L.E., September 16, 1926, as a junior electrical engineer. He was promoted to operation inspector in the engineering department on November 1, 1927, to electrical foreman on March 1, 1929, and to electrical supervisor on September 1, 1933. In September, 1941, he was appointed signal-electrical engineer.

Robert C. Charlton, signal engineer, Northwestern district of the Union Pacific, with headquarters in Portland, Oregon, was born in San Francisco, California, July 12, 1881. He received his education at the California School of Mechanical Arts, graduating in 1900. He entered railway service with the Southern Pacific on January 2, 1901 as a signal apprentice at Ocean View, Cal., subsequently being promoted to lampman, batteryman, signalman, and signal gang foreman in 1905. In June 1905 he entered the service of the Oregon - Washington Railroad and Navigation Company (now part of the Union Pacific) in the same capacity. From 1907 to 1908 he served as general construction foreman, then signal supervisor, and on January 1, 1921, he was promoted to signal engineer. On September 1, 1931, at the time of the reorganization, he assumed the duties of signal supervisor of the Northwestern district of the U.P. He was promoted to signal engineer of the same district in August, 1941.

Arthur Stead Haigh, assistant signal engineer, New York Central, Buffalo and East, with headquarters in Albany, N.Y., was born in Utica, N.Y., July 29, 1886, and first entered railway service in August, 1902, as a telegraph operator on the R.W. and O., which is now the St. Lawrence division of the New York Central. In September, 1908, he left railroad service to attend the Rensselaer Polytechnic Institute, and in 1910 re-entered the service of the New York Central as a draftsman in the signal engineer's office in Albany. In September, 1919, he was appointed chief draftsman, and in May, 1929, made office engineer. On April 1, 1940, he was promoted to assistant signal engineer. Mr. Haigh has been active in the Signal Section, A.A.R., since 1921 and is a member of the A.R.E.A.

William Francis Price, assistant signal engineer, Coast Lines of the A.T. and S.F., with headquarters in Los Angeles, was born in Beloit, Kansas, July 10, 1888. He attended high school in Topeka, Kansas, and graduated from the University of Kansas with a degree in electrical engineering in June, 1913. Between school sessions he worked in the auditing department, in the Topeka shops, and in the signal department of the Santa Fe. He worked with a repair gang on the New Mexico division, then as a wireman and maintainer. After graduation from the university, he started continuous service with the Santa Fe as a draftsman in the signal engineer's office, Eastern Lines, in June, 1913.

Subsequently he served as chief draftsman in the system signal engineer's office, and in October, 1920, he was appointed assistant signal engineer of the Coast Lines. In July, 1939, he became signal engineer of the G.C. & S.F., returning to the Coast Lines of the Santa Fe as assistant signal engineer in June, 1944.

Bernard J. Schwendt, assistant signal engineer, C.C.C. & St.L., with headquarters in Cincinnati, Ohio, was born in Green Springs, Ohio, July 25, 1884. After completing high school he entered Ohio State University, receiving his M.E. in 1907. In 1924 he studied with the Alexander Hamilton Institute, and in 1936 at his alma mater, Ohio State University, he received his E.E. degree.

Mr. Schwendt started his railroad experience in 1902 on the GN. In 1905 and '06 he worked in the summer months with Bullock Electric Co. (now Allis-Chalmers Co.) in Cincinnati; from 1907 to 1909 he was installing and maintaining railway signaling and interlocking apparatus for the U.S. & S. Co. From 1909 to 1912 he was supervisor of signals of the Hocking Valley Ry. (C & O), Toledo and O.C., K. & M., Zanesville and Westn., Kanawha and West Virginia and Gauley & Eastn. (now all N.Y.C.). In 1912 he became signal and electrical engineer of the Ohio Central Lines (N.Y.C.); in 1915 superintendent telegraph and signals and electrical engineer, same lines, taking in the Hocking Valley in 1918; in 1925 assistant signal engineer, N.Y.C. Lines West, Ohio Central Lines, I.H.B., Chi. Jct. Ry. and Chicago River & Indiana; in 1937 assistant signal engineer N.Y.C. System, assigned to the C.C.C. & St.L. Territory.

Taking an active part in signaling affairs, Mr. Schwendt is a member of the Telegraph and Telephone Section, A.A.R., a member of the Signal Section, A.A.R., and a member of the A.R.E.A. His activities with the Signal Section are chairman of the Section, 1937 and 1938, and member, Committee of Direction since 1934; chairman of Comm. III - Power Interlocking, 1922-23; chairman Comm. I - Economics of Railway Signaling 1931-35; chairman Special Committee on Indexing 1936-39; conferee, representing Sig. Sect. on work of revising Natl. Elec. Safety Code, 1936; chairman Special Committee on Revision of Regulation, 1937.

Besides his affiliation with the A.A.R and the A.R.E.A., Mr. Schwendt was secretary, N.Y.C. Lines Sig. and Train Control Comm., 1926-37; is vice chairman, Eng. Research Advisory Comm. and vice chairman, Gen. Comm. Eng. Div. A.A.R., and member of the Am. Assn. of R.R. Supts., Cleveland Eng. Society and the Cincinnati Traffic Club.

He has written articles for the Telegraph and Telephone Age (1918-22), Railway Age (1923-27), Railway Signaling (1919-39) and Bulletin of Intl. Ry. Congress (Dec. 1927).

P. G. Seaholm, assistant superintendent of signals, Great Northern, with headquarters in St. Paul, Minn., was born in Skurup, Sweden, July 25, 1895. After finishing grade and high schools, he completed an electrical engineering course with the International Correspondence Schools. He entered railway service with the Great Northern on January 3, 1919, and served successively as signal maintainer's helper, signal maintainer, draftsman, signal inspector and office engineer. On May 1, 1938, he was promoted to assistant superintendent of signals.

J. S. Webb, signal and telephone engineer, Atlantic Coast Line, with headquarters in Wilmington, N.C., was born in Baltimore, Md., on July 22, 1893. He graduated from the Baltimore Polytechnic Institute in June, 1912, and entered the service of the Washington Terminal Company in the same year as a helper on signal construction. In September, 1912, he joined the B. & O. as lampman, was promoted to batteryman. In May, 1913, he became signal draftsman in the signal engineer's office in Baltimore. On January 1, 1914, he was furloughed from this position to work as draftsman and transitman in the chief engineer's office, United Railways and Electric Co. in Baltimore. In April, 1916, he re-entered the service of the B. & O. as circuit draftsman, leaving in September, 1917, to enter the signal department of the Western Maryland as chief draftsman. He was promoted to inspector in September, 1920, and to signal and telephone engineer in February, 1940. In April, 1942, he was appointed assistant superintendent of signals of the Atlantic Coast Line and, in August of the same year, signal engineer. He became signal and telephone engineer May 1, 1946.

* * *

Pen-Type Recorder for CTC

A new pen-type recorder for centralized traffic control has been designed and built. Recorders of this type are being furnished on control machines ordered by the C.B. & Q., L. & N., and N.P.

Instead of writing up a special article on this recorder for the NEWS, we are attaching a copy of Pamphlet 597 which has been prepared for the men who are to use and maintain the machine. From this pamphlet you will be able to get a good understanding of its operation, maintenance and adjustment.

* * *

GENERAL RAILWAY SIGNAL COMPANY

G-R-S NEWS
May 1946

Two-Rate Charge Control Relay

Recently perfected and given extensive tests on a number of trial installations, the Types K and B two-rate charge control relays have been readily received. In this issue of the NEWS their features and applications are described to supplement the information that has all ready appeared in our advertisements and in the "New Device" columns of Railway Signaling.

A development sheet on these relays is in the making, and, as is customary, we would like to have your comments and additions, within the next two weeks, to the information contained herein. It will help us to make the development sheet more complete and useful for all who refer to it.

—— * ——

I. PURPOSE OF RELAY

At certain signal locations, the electrical power load is irregular and varies over wide limits. For example, at a highway crossing signal location the normal load is practically zero, but when a train is approaching and the lights are flashing,the load may be from 2 to 4 or more amperes. Another example is in switch control applications. You can readily think of numerous other applications that offer the same problem.

Such variable loads make it difficult to maintain a battery in a fully charged condition and yet not overcharge it excessively. It is a well recognized fact that to keep a battery charged at a predetermined trickle-charge rate, and at the same time not incur danger of overcharging, requires diligent maintenance and frequent readjustment of the trickle-charge rate.

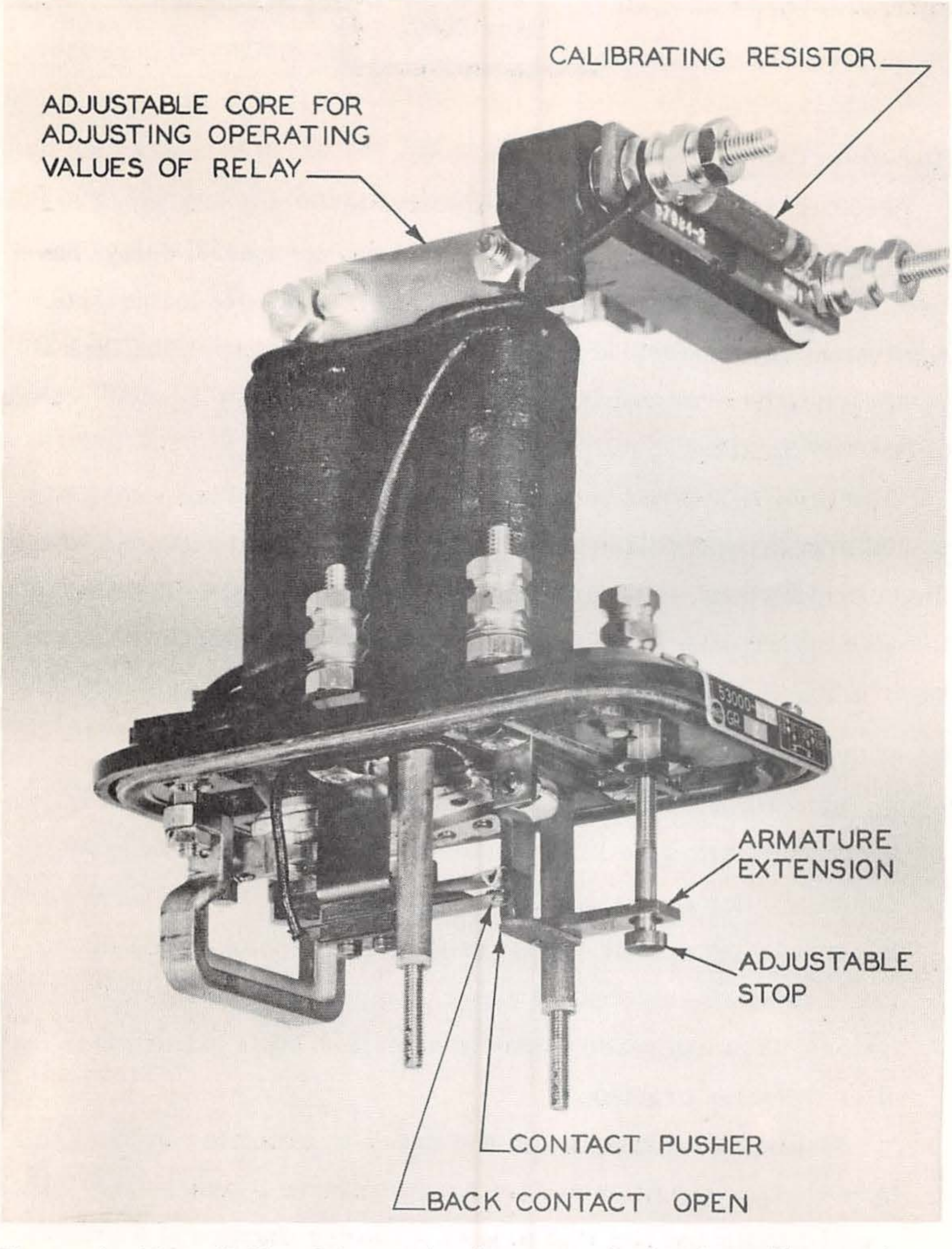

CALIBRATING RESISTOR
ADJUSTABLE CORE FOR ADJUSTING OPERATING VALUES OF RELAY
ARMATURE EXTENSION
ADJUSTABLE STOP
CONTACT PUSHER
BACK CONTACT OPEN

Figure 1. Type K Size 2 two-rate charge control relay with armature shown picked up (glass cover removed).

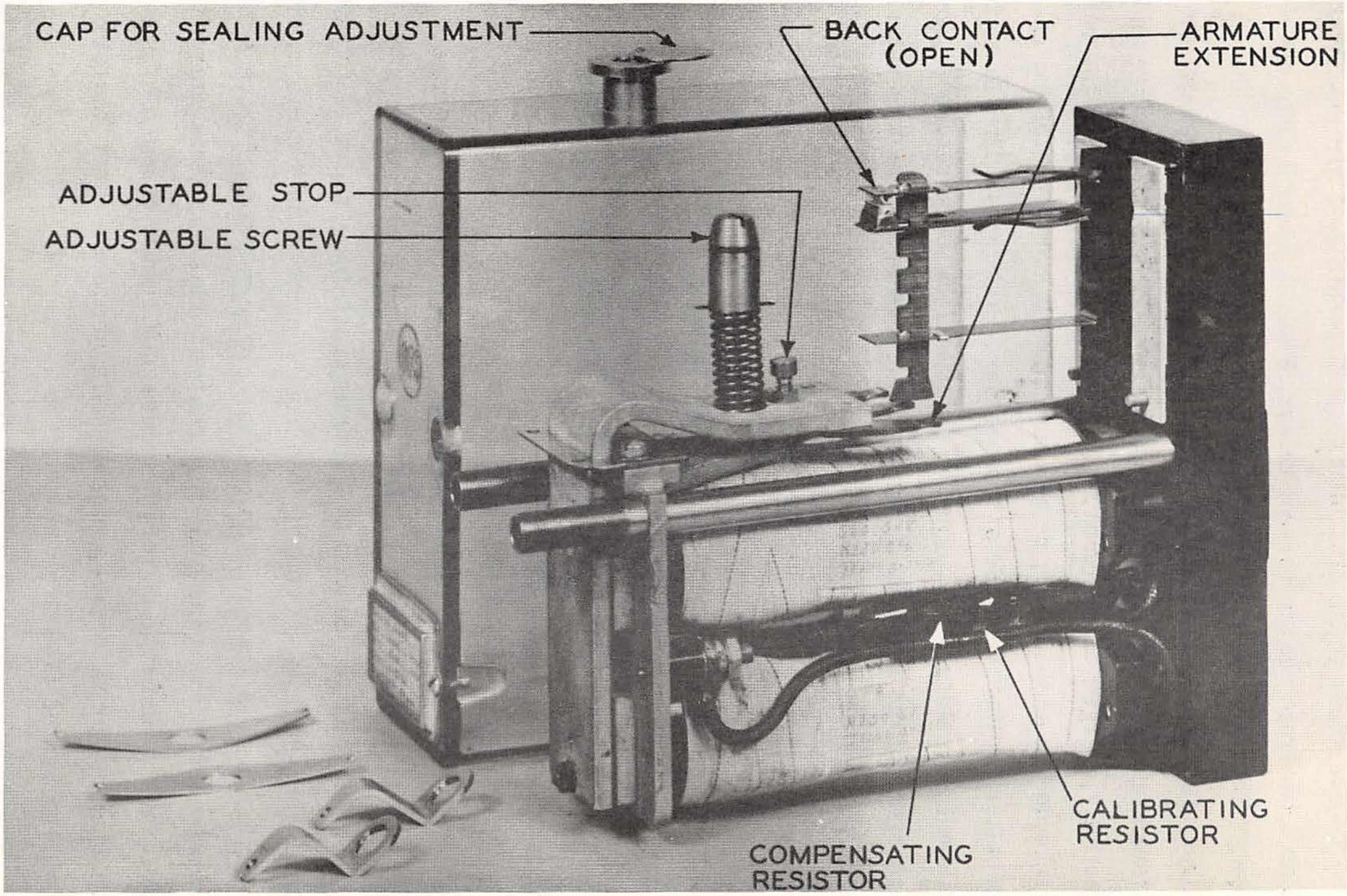

CAP FOR SEALING ADJUSTMENT
BACK CONTACT (OPEN)
ARMATURE EXTENSION
ADJUSTABLE STOP
ADJUSTABLE SCREW
CALIBRATING RESISTOR
COMPENSATING RESISTOR

Figure 2. Type B Size 1 two-rate charge control relay with armature shown picked up (plastic cover removed and plugboard omitted).

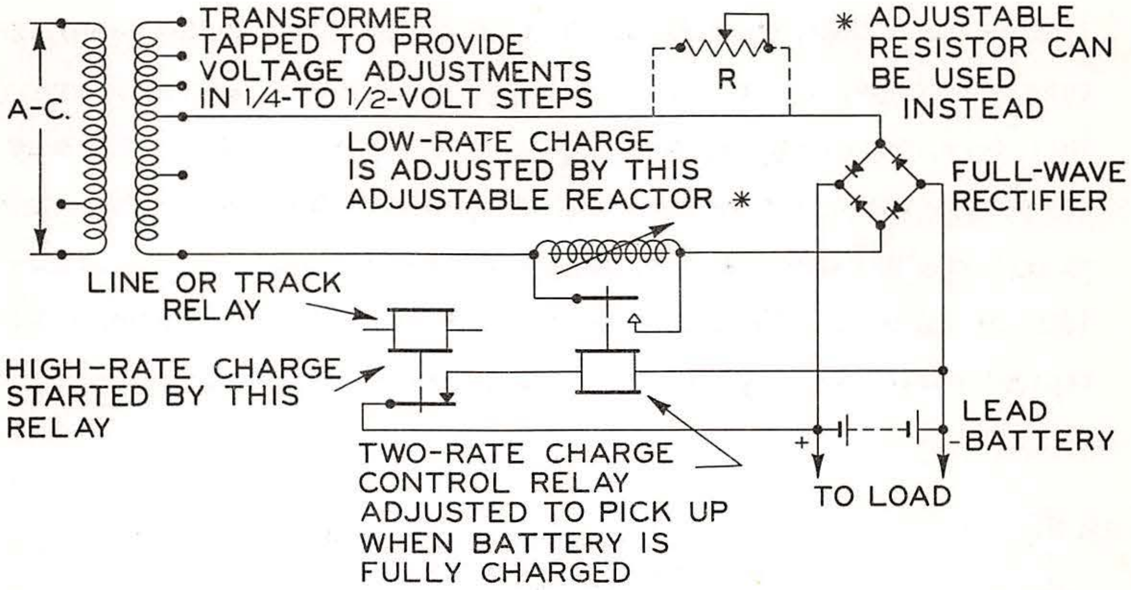
To overcome these difficulties the Type K Size 2 and the Type B Size 1 two-rate charge control relays, Figures 1 and 2, were developed. The relay is used in battery charging circuits to initiate a high rate of charge when it is deenergized by external means, and to transfer from a high-rate to a safe continuous low-rate charge as the fully charged condition of the battery is approached and the relay picks up. In addition, the relay automatically compensates for changes in battery voltage because of temperature variations. This is accomplished by making the "voltage versus ambient temperature" characteristic of the relay, as shown by the curve in Figure 4, similar to that of a lead battery when on charge and approaching a fully charged condition. For proper operation it is desirable that the relay be so located that it will be subject to approximately the same ambient temperature conditions as the battery.

II. THEORY OF OPERATION

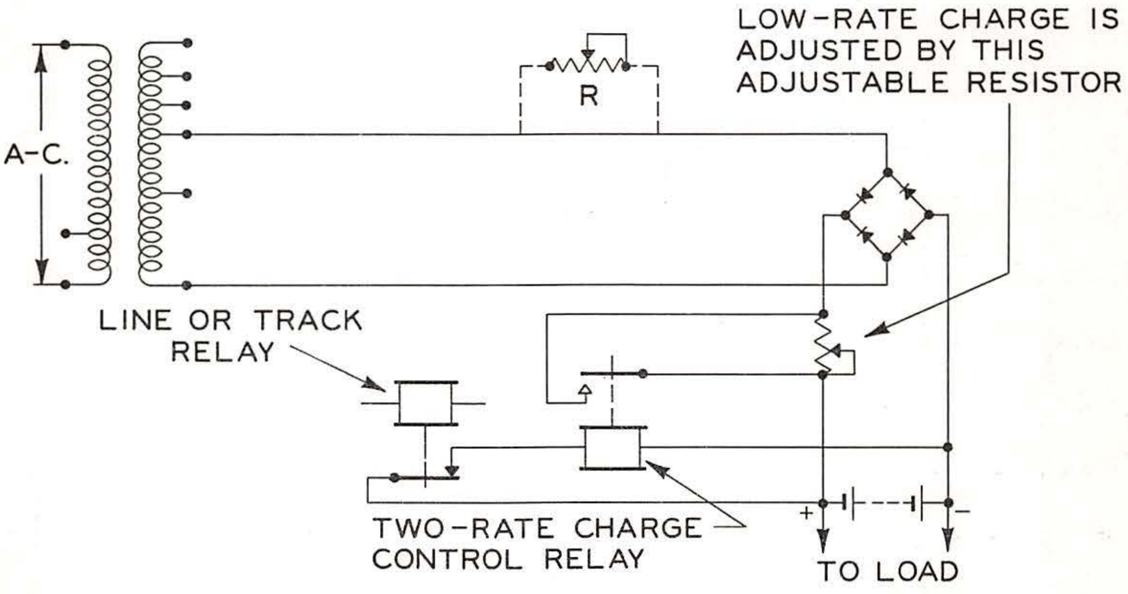
The charge control relays described herein are applicable only to lead storage cells.

Figure 3 shows a typical circuit for the two-rate charge control relay wired to control the high and low charge rate of a storage battery from a full-wave rectifier. The relay is released by the opening of the front contact of a line or track relay which is actuated whenever a high load occurs. The back contact of the charge control relay shunts the reactor, Figure 3 (a), or the resistor, Figure 3 (b), thereby establishing the high-rate charge. This high-rate charge will continue until the battery becomes sufficiently charged to cause the charge control relay to pick up and remove the shunt, thereby establishing the low-rate charge.

Since the voltage of a lead cell decreases as the cell temperature increases, the two-rate charge control relay is designed with inverse


A-C.
TRANSFORMER TAPPED TO PROVIDE VOLTAGE ADJUSTMENTS IN 1/4-TO 1/2-VOLT STEPS
R
* ADJUSTABLE RESISTOR CAN BE USED INSTEAD
LOW-RATE CHARGE IS ADJUSTED BY THIS ADJUSTABLE REACTOR *
FULL-WAVE RECTIFIER
LINE OR TRACK RELAY
HIGH-RATE CHARGE STARTED BY THIS RELAY
TWO-RATE CHARGE CONTROL RELAY ADJUSTED TO PICK UP WHEN BATTERY IS FULLY CHARGED
+
LEAD -BATTERY
TO LOAD

(a) With adjustable reactor for adjusting the low-rate charge. This circuit can be used only where it is convenient to connect to leads of the reactor.


A-C.
R
LOW-RATE CHARGE IS ADJUSTED BY THIS ADJUSTABLE RESISTOR
LINE OR TRACK RELAY
TWO-RATE CHARGE CONTROL RELAY
+
-
TO LOAD

(b) With adjustable resistor for adjusting the low-rate charge. This circuit has general application.

Figure 3. Typical application circuits of the two-rate charge control relay. Adjustable resistor "R" is to be added if transformer does not give the required degree of adjustment for high-rate charge.

temperature characteristics. That is, as the surrounding temperature increases, the overall resistance of the relay decreases and, therefore, the pickup voltage required also decreases. In this way the pickup value is automatically compensated for temperature and practically parallels the "voltage versus temperature" characteristic of the lead cells across which it is connected. See Figure 4 for typical curve of relay's pickup voltage versus temperature.

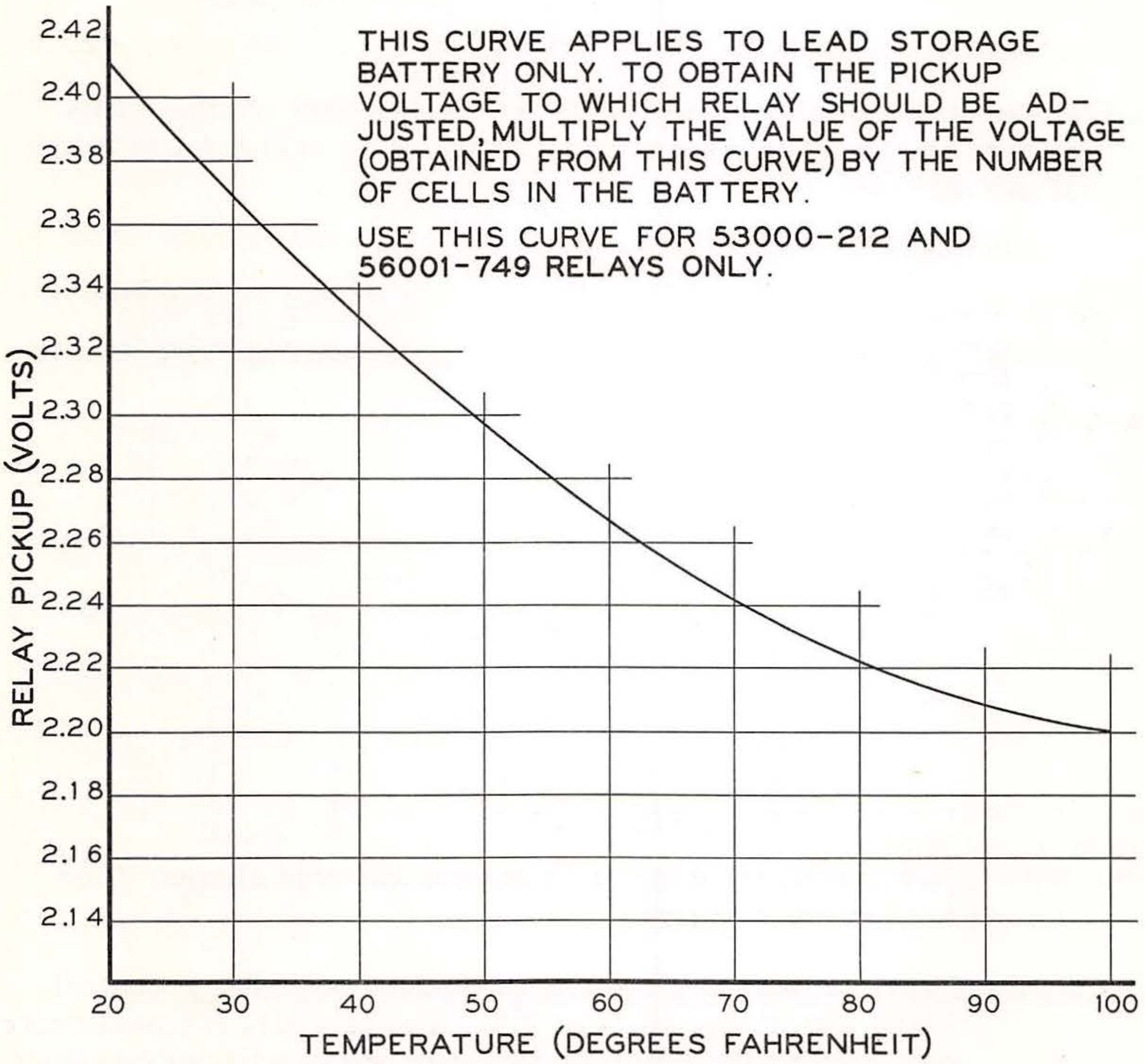


Figure 4. Relay's pickup voltage versus temperature.

The voltage of a lead cell on charge increases slowly until the battery approaches full charge and begins to gas, at which time the voltage rises rapidly and becomes stable at the maximum value for the particular charge rate being applied. The charge control relay is adjusted to pick up at a value slightly under this maximum value, thus insuring full charge without over-charging.

The high charge rate may be equal to the rectifier's rated continuous d-c. output or some lower rate which is calculated to be the one best suited to the requirements of the particular location. The low charge rate should be that which is calculated adequate to keep the battery in a good condition with its steady load.

III. RELAY PICKUP ADJUSTMENT

All relays are shipped, adjusted to pick up on minimum voltage. Each relay must be adjusted to pick up on a voltage determined by the conditions existing at the individual location at which it is to be used.

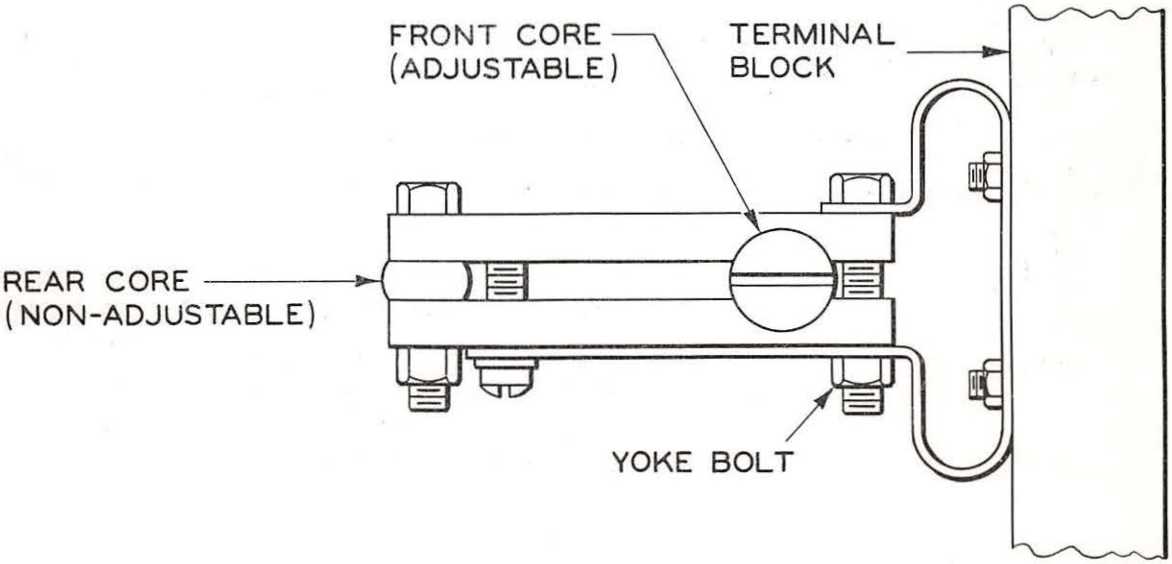
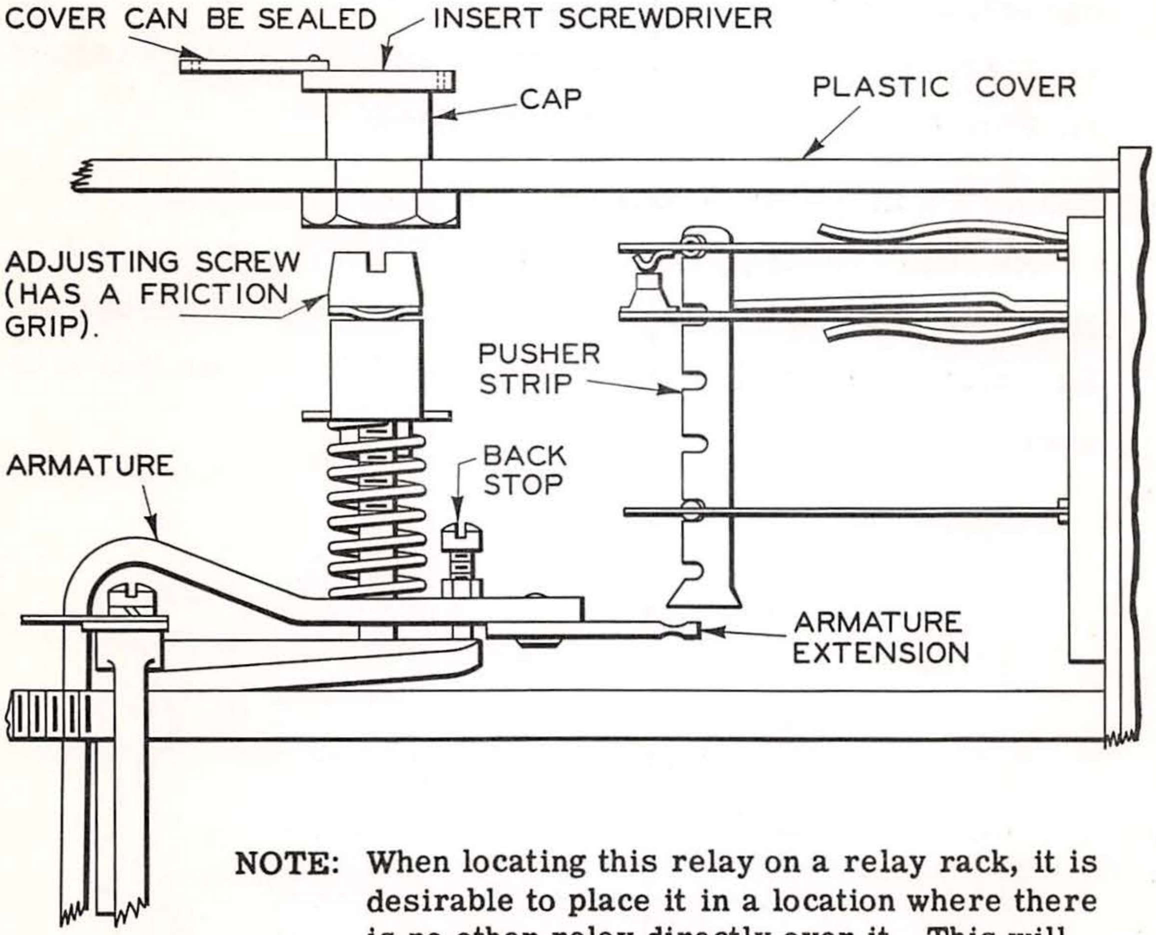


Figure 5. Relay pickup adjustment (Type K).

To increase the pickup value of the Type K relay, Figure 5, loosen the yoke fastening bolt slightly and turn the front core counter-clockwise, using the screwdriver slot in the top of the core, until the required pickup value is obtained. The core fastening bolt should then be tightened and the relay pickup checked several times to be sure it has stabilized. Relay should be energized at a value only slightly above the pickup value before opening the circuit and taking the pickup.


COVER CAN BE SEALED
INSERT SCREWDRIVER
CAP
PLASTIC COVER
ADJUSTING SCREW (HAS A FRICTION GRIP).
PUSHER STRIP
ARMATURE
BACK STOP
ARMATURE EXTENSION

NOTE: When locating this relay on a relay rack, it is desirable to place it in a location where there is no other relay directly over it. This will make it easier to get at the adjustment after the relay is in regular service.

Figure 6. Relay pickup adjustment (Type B).

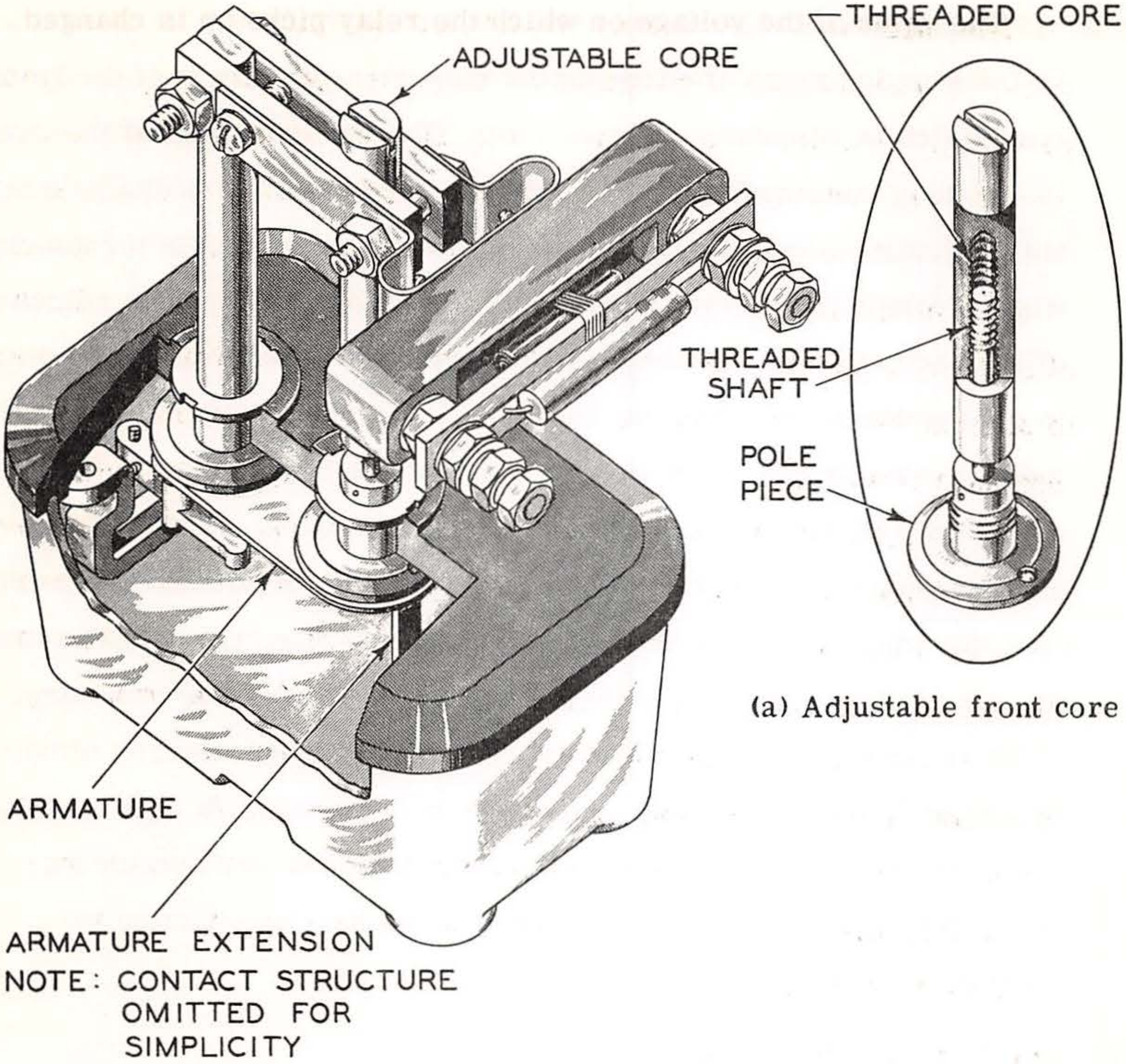
The value of the voltage on which the relay picks up is changed by the simple means of changing the magnetic reluctance of the front core which is adjustable, Figure 7 (a). The upper portion of the core is bored out and threaded. The lower portion consists of the pole face with a threaded shaft pinned to it. As the upper portion is turned clockwise it comes into closer contact with the pole piece and the reluctance of the core assembly decreases. Therefore, less voltage is required to pick up the relay. Turning the core counterclockwise increases the magnetic reluctance and the relay requires more voltage to pick up.

To increase the pickup value of the Type B relay, Figure 6, insert a screwdriver through the sealing cap provided in the plastic cover and turn the adjusting screw clockwise. This increases the compression of the spring, thus requiring a higher voltage to pick up the armature.

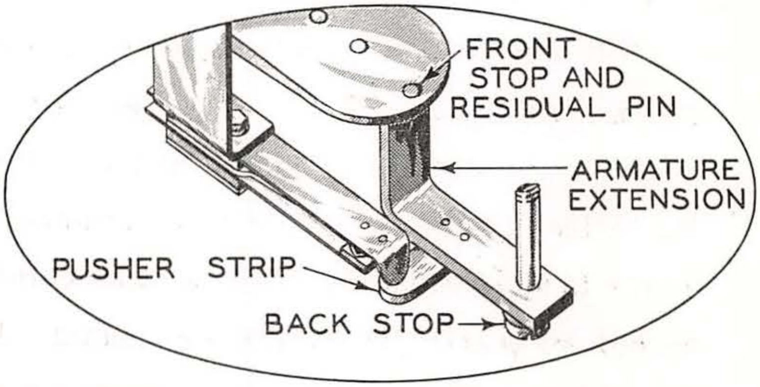
It is always desirable to adjust the relay at temperatures of not less than 65 degrees F. and no more than 85 degrees F. Should it be necessary to make this adjustment at any temperature outside this range, a further check should be made when the temperature has returned to normal.

IV. CONTACT OPERATION

The armature of both the Type K and the Type B relay has an extension rivetted to it. See Figures 6 and 7 (b). The extension, Figure 7 (b), carries an insulated strip which, when the armature picks up, strikes the upper spring of the contact, thus opening the contact. There is approximately 1/8 inch of armature travel before the insulated pusher strip actually strikes the contact. This enables the armature to build up sufficient momentum on pickup to carry it through to the front stop at the same time opening the contact with a clean, definite break. It also eliminates any opening and closing of the contact because of vibration effects on the armature. In the B relay the insulated pusher strip is part of the contact assembly, Figure 6.


THREADED CORE
ADJUSTABLE CORE
THREADED SHAFT
POLE PIECE
ARMATURE
ARMATURE EXTENSION
NOTE: CONTACT STRUCTURE OMITTED FOR SIMPLICITY

(a) Adjustable front core


FRONT STOP AND RESIDUAL PIN
ARMATURE EXTENSION
PUSHER STRIP
BACK STOP

(b) Contact detail

Figure 7. Contact and adjustable core details of Type K two-rate control relay.

V. TEMPERATURE COMPENSATING AND CALIBRATING RESISTORS

These resistors are carried on the terminal block of the Type K relay. The temperature compensating resistor is toward the back of the block and the calibrating resistor is on the front. These two resistors, in parallel with one another and in series with the windings, serve to produce the characteristic curve given in Figure 4. They are matched, the one with the other. If one is broken or otherwise damaged, the relay must be recalibrated with a new resistor to meet the values given on the curve in Figure 4. Resistors can be purchased in matched sets. Specify relay ordering reference number.

The detailed wiring is shown in Figure 8, where it will be seen that the positive terminal of the relay coil is on the terminal block and the negative terminal is on the molded plastic cover of the relay. This is unlike other Type K relays whose coil terminals are on the terminal block only.

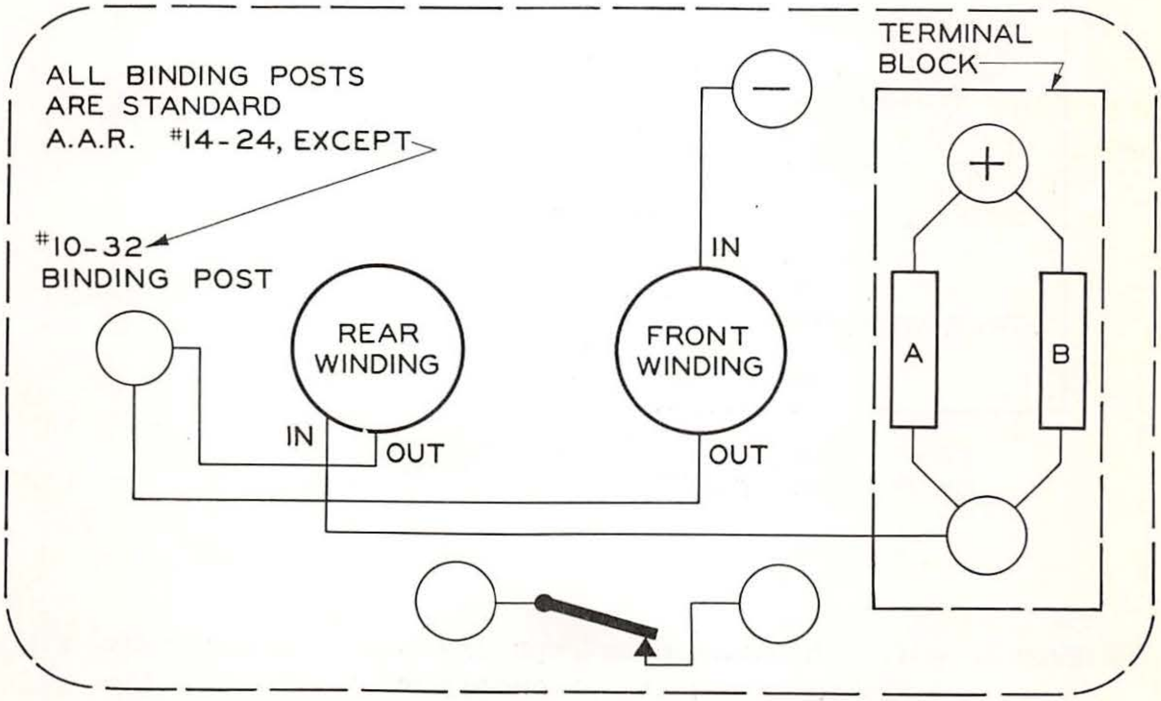

ALL BINDING POSTS
ARE STANDARD
A.A.R. #14-24, EXCEPT
#10-32
BINDING POST
REAR
WINDING
IN
OUT
FRONT
WINDING
IN
OUT
TERMINAL
BLOCK
+
—
A
B

Figure 8. Wiring diagram of the Type K two-rate charge control relay. A is the temperature compensating resistor; B is the calibrating resistor.

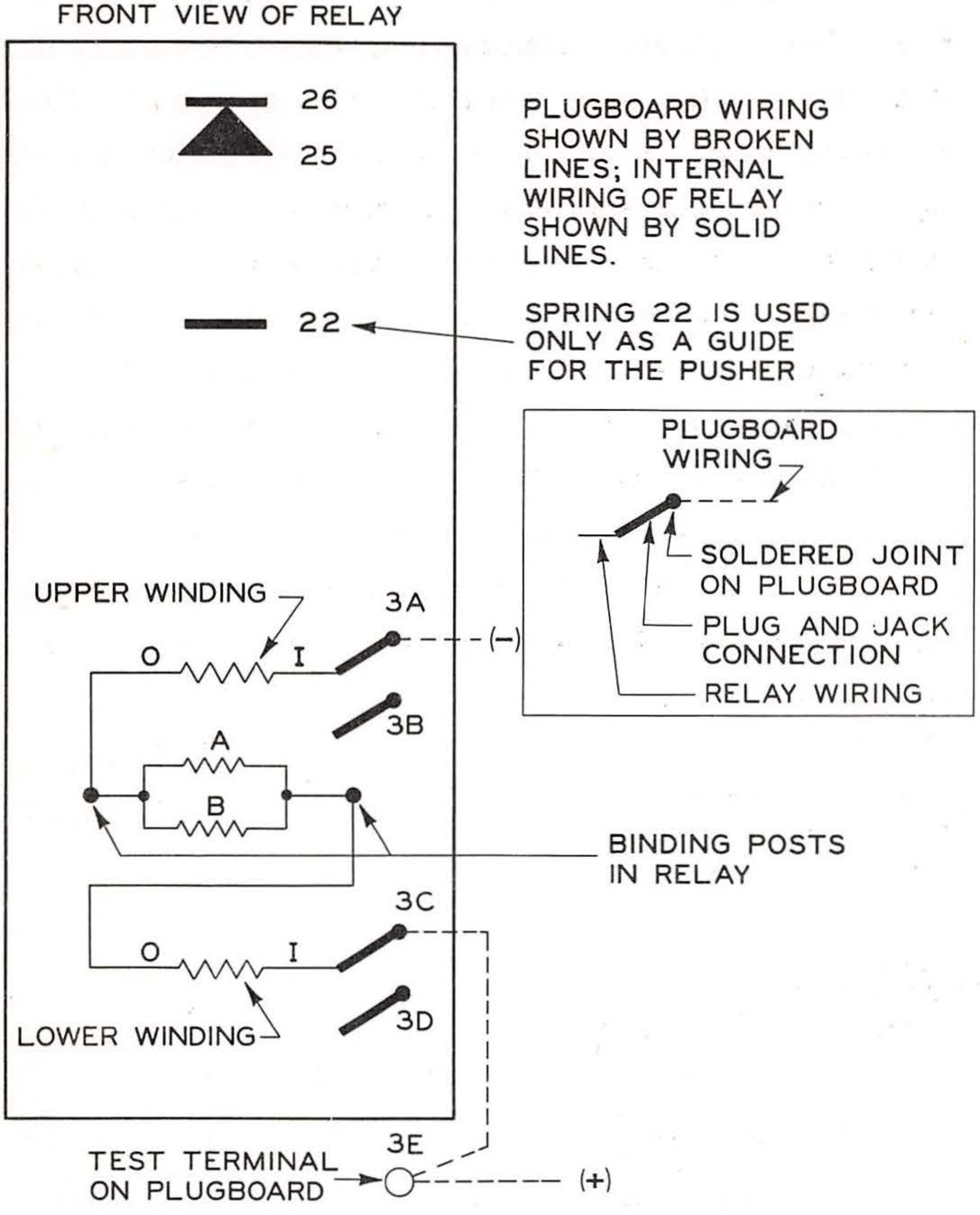

FRONT VIEW OF RELAY
26
25
PLUGBOARD WIRING SHOWN BY BROKEN LINES; INTERNAL WIRING OF RELAY SHOWN BY SOLID LINES.
22
SPRING 22 IS USED ONLY AS A GUIDE FOR THE PUSHER
PLUGBOARD WIRING
SOLDERED JOINT ON PLUGBOARD
PLUG AND JACK CONNECTION
RELAY WIRING
UPPER WINDING
3A
O
I
(–)
3B
A
B
BINDING POSTS IN RELAY
3C
O
I
LOWER WINDING
3D
3E
TEST TERMINAL ON PLUGBOARD
(+)

Figure 9. Wiring diagram of the Type B two-rate charge control relay. A is the temperature compensating resistor; B is the calibrating resistor.

On the Type B relay the resistors are supported near the coils and inside the plastic cover. The wiring diagram is shown in Figure 9.

VI. ADJUSTMENT OF HIGH AND LOW CHARGE RATES

The high charge rate is adjusted by varying the a-c. voltage on the rectifier with the charge control relay deenergized, its back contact shunting the adjustable reactor, Figure 3(a), or adjustable resistor, Figure 3(b), as the case may be. The transformer voltage adjustment should be fine enough to give fairly close regulation, or an adjustable resistor, R, may be added.

With the battery slightly discharged and no load, or only a small steady load on the battery, apply a charge to bring the battery voltage up to 2.15 volts per cell, and then adjust the high-rate charge current to a value slightly under the rated continuous output of the rectifier, which should have sufficient capacity to insure replacement of battery discharge within the time available.

Continue the charge until the cells gas freely and the specific gravity stops rising. The voltage will rise above 2.15 volts per cell and the charging current will decrease.

Record the final charging current as this value is used in the calculations. See page 15, under B, 3.

The low charge rate should be adjusted with the contact of the charge control relay open. This is to be done, after the high charge rate adjustment has been made, by varying the reactor or resistor until a charge sufficient to supply the steady battery drain and the battery losses has been obtained. Battery losses at 68 degrees F. may be assumed to be 0.5 percent of the calculated 8-hour rate. This setting should also be made with the battery voltage at 2.15 volts per cell.

VII. INSTALLATION AND ADJUSTMENT

Two methods of installation and adjustment are described; (1) the practical method, which is simple and can be used with good results provided the battery is checked to insure that the relay has been properly adjusted; (2) the calculated method, which provides more detailed information and results in a more exact setting of the pickup. Choice of method depends on the individual.

A. Practical Method

1. Rectifier must have sufficient capacity to insure rapid recharge after discharge.
2. The resistor or reactor, used to adjust the low charge rate, must be of sufficient resistance or impedance to obtain the low charge current and must have sufficient capacity to carry this current.
3. Connect the two-rate charge control relay directly across the battery. Connect the contact of the relay across the resistor or reactor.
4. With the coil circuit of the t-r.c.c. relay opened, and the contact shunting out the resistor or reactor, adjust the high charge current to a point slightly under the continuous current rating of the rectifier.
5. With the contact circuit of the t-r.c.c. relay opened, adjust the low charge rate.
6. Adjust the pickup voltage of the t-r.c.c. relay in accordance with the temperature which is prevailing at the time the t-r.c.c. relay is installed. Use the values given below:

Temp. Deg. F.	50	60	70	80	90
Pickup Volts	2.29	2.26	2.24	2.22	2.21

7. Connect all wires to relay and test relay pickup by charging battery. When battery approaches full charge, relay should pick up.
8. Battery should be tested for specific gravity periodically after installation to insure that it is being kept fully charged and that the relay is operating properly.

B. The Calculated Method

1. Calculate the 8-hour charge rate of the battery, which is the ampere-hour capacity divided by 8 hours.
2. Find the steady discharge from the battery in amperes; this is the sum of steady relay, signal, or other current plus internal losses in the battery assumed to be 0.5 percent of the 8-hour charge rate.
3. Obtain the final (high-rate) rectifier output in amperes when the battery is fully charged. This can be obtained by test when the cells gas freely and the specific gravity stops rising. The voltage will rise above 2.15 volts per cell and the charging current will decrease during this process. Record the final charging current with the coil circuit of the t-r.c.c. relay open.
4. Find the input to the battery (in amperes) by subtracting the steady battery discharge (in 2 above) from the final high-rate rectifier output (in 3 above).
5. Calculate the percentage relation of the input amperes to the 8-hour charge amperes, or

$$\frac{\text{battery input amperes (in 4 above)}}{\text{8-hour charge amperes (in 1 above)}} \times 100$$

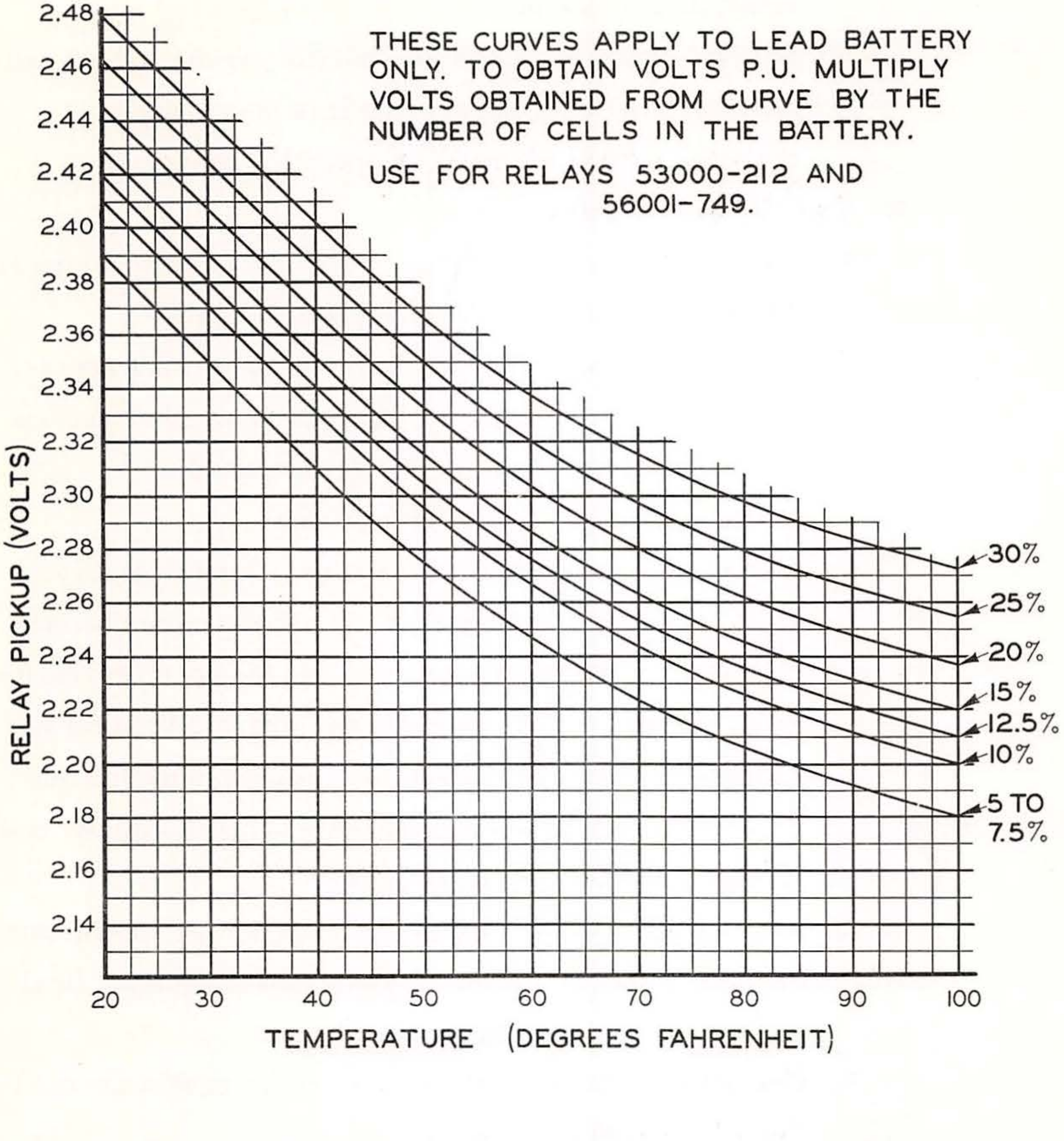


Figure 10. Pickup voltage of relays (per cell of battery) versus ambient temperature, at various percentages of the high charge rate.

C. The Carrier Telephone Systems

The full list of carrier telephone systems, which have been installed by Western Electric, is given on the opposite page. Brief notes on each system follow.

The frequency allocations for the twelve types of systems are shown in the chart on the next page.

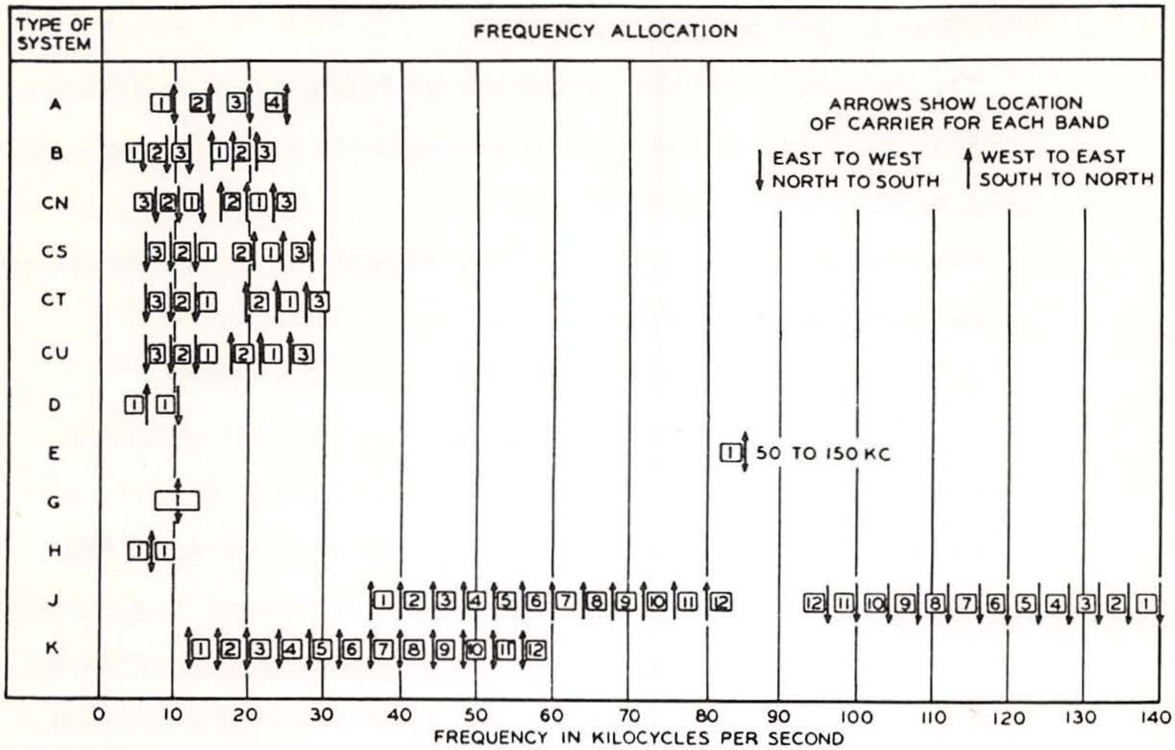
1. Type A Carrier System

This system, developed during World War I, provides four two-way channels above the voice channel on one open-wire pair. Each channel uses the same frequency for both directions of transmission. The lower sidebands* of carrier frequencies at 10, 15, 20, and 25 kilocycles are used, with the carrier suppressed. Direction of transmission is discriminated by impedance balance in so-called "hybrid coils".

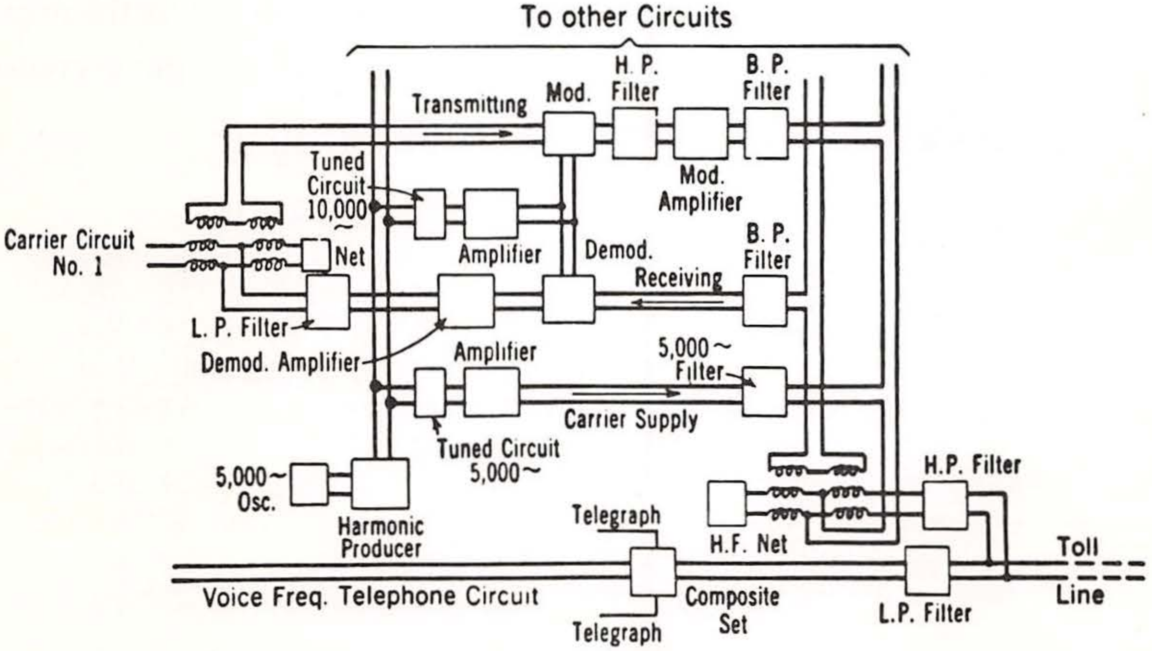
This system provides good service, but the number of systems that can be placed on a pole line is limited by near-end crosstalk, and the repeater gains are limited by the degree of balance obtainable from the hybrid coil; hence the usefulness of the system for very long circuits is reduced.

---

* When a carrier wave is modulated by voice frequencies, the carrier wave is actually distorted and new frequencies are created. Among these new frequencies there are two groups which are called the "upper sideband" and the "lower sideband." For example, if a voice-frequency wave of V cycles is used to modulate a carrier wave of C cycles, an analysis of the modulated wave shows that it contains a carrier-frequency component C, an upper sideband of C + V, and a lower sideband of C - V. The advantages of transmitting the sideband alone are: smaller amplifier capacity; reduction in crosstalk and noise interference; simpler selectivity requirements for the band filters.



Seven Type A systems were installed, but, by 1938, only one was in regular service and that was between Merced and Yosemite Valley, California.

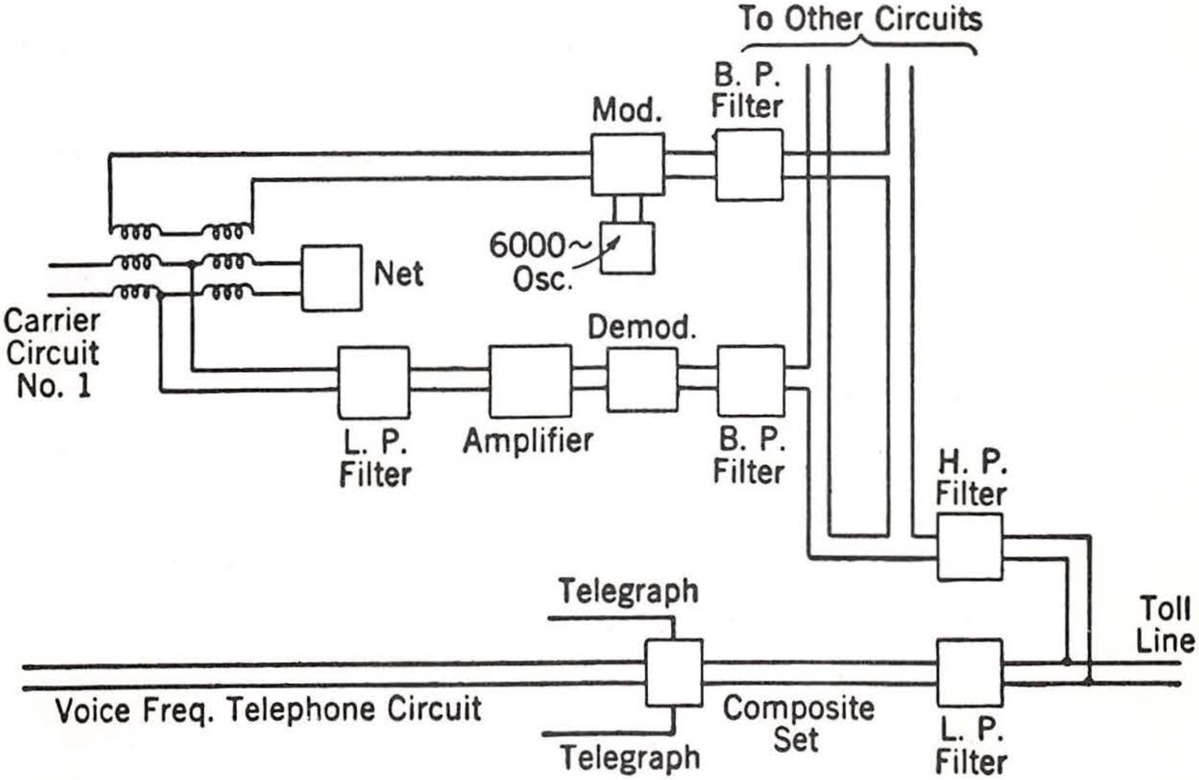

To other Circuits
Transmitting
Mod.
H. P. Filter
B. P. Filter
Tuned Circuit 10,000~
Mod. Amplifier
Carrier Circuit No. 1
Net
Amplifier
Demod.
B. P. Filter
Receiving
L. P. Filter
Demod. Amplifier
Amplifier
5,000~ Filter
Carrier Supply
Tuned Circuit 5,000~
5,000~ Osc.
Harmonic Producer
H.P. Filter
Telegraph
H.F. Net
Toll Line
Voice Freq. Telephone Circuit
Composite Set
Telegraph
L.P. Filter

Schematic diagram of one channel of a Type A carrier telephone system.

2. Type B Carrier System

This system, which followed the Type A, provides three channels above the voice channel. Different frequencies are used for transmission in opposite directions, and, for this reason, this system can use higher repeater gains. It is also possible to rely upon filter selectivity instead of impedance balance to separate the directions of transmission.

This system transmits a single sideband and the carrier frequency, using the lower sidebands of carrier frequencies at 6, 9, and 12 kilocycles in the east to west (or north to south) direction, and the upper sidebands of carrier frequencies at 15, 18, and 21 kilocycles in the west to east (or south to north) direction. The carrier wave is transmitted to eliminate the harmonic-generator equipment.


To Other Circuits
Mod.
B. P. Filter
6000~ Osc.
Net
Carrier Circuit No. 1
Demod.
L. P. Filter
Amplifier
B. P. Filter
H. P. Filter
Telegraph
Toll Line
Voice Freq. Telephone Circuit
Composite Set
L. P. Filter
Telegraph

Schematic diagram of one channel of a Type B carrier telephone system.

The difficulties with the Type B system are that the band width obtainable in each channel is somewhat narrower than is desirable, and that transmission of the carrier places an unnecessarily large burden on the load-carrying capacity of the repeaters.

Of the Type B systems placed in service, only one is now in operation, between Spokane and Lewiston in the state of Washington.

3. Type C Carrier System

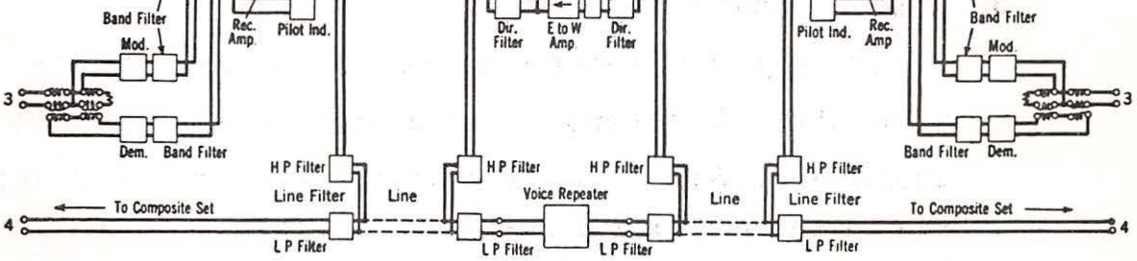
This system, used almost exclusively on long lines, has the most desirable features of the Types A and B systems. It provides three talking circuits and uses different frequencies for transmission in opposite directions. A single sideband is transmitted for each channel, but the carrier is suppressed. Filter selectivity is used to separate the different frequencies. The system is being used on open-wire lines, some of which are over 2,000 miles long. Repeaters are spaced at intervals of 150 to 300 miles.

Type C systems having three slightly different frequency allocations were developed and were designated as the Types CN, CS, and CT systems. As progress was made in the art, improvements were incorporated in these systems, and successive models were standardized, which were designated as the C2, C3, and C4, with a letter added to indicate the frequency allocation used in each case as CN4, CS4, and CT4.

During recent years there have been a number of new developments such as copper-oxide modulators and demodulators, and filters employing molybdenum-permalloy coils, which have made it possible to reduce materially the cost and physical size of the equipment. In addition to these, new types of vacuum tubes have become available, having higher gains than those used heretofore, and the feedback type of amplifier has been developed, which is much more suitable for carrier use than the types previously employed. A new Type C system, known as the C5, embodies all of these improvements. It is provided in the CS frequency allocation and in a new frequency allocation known as the CU.

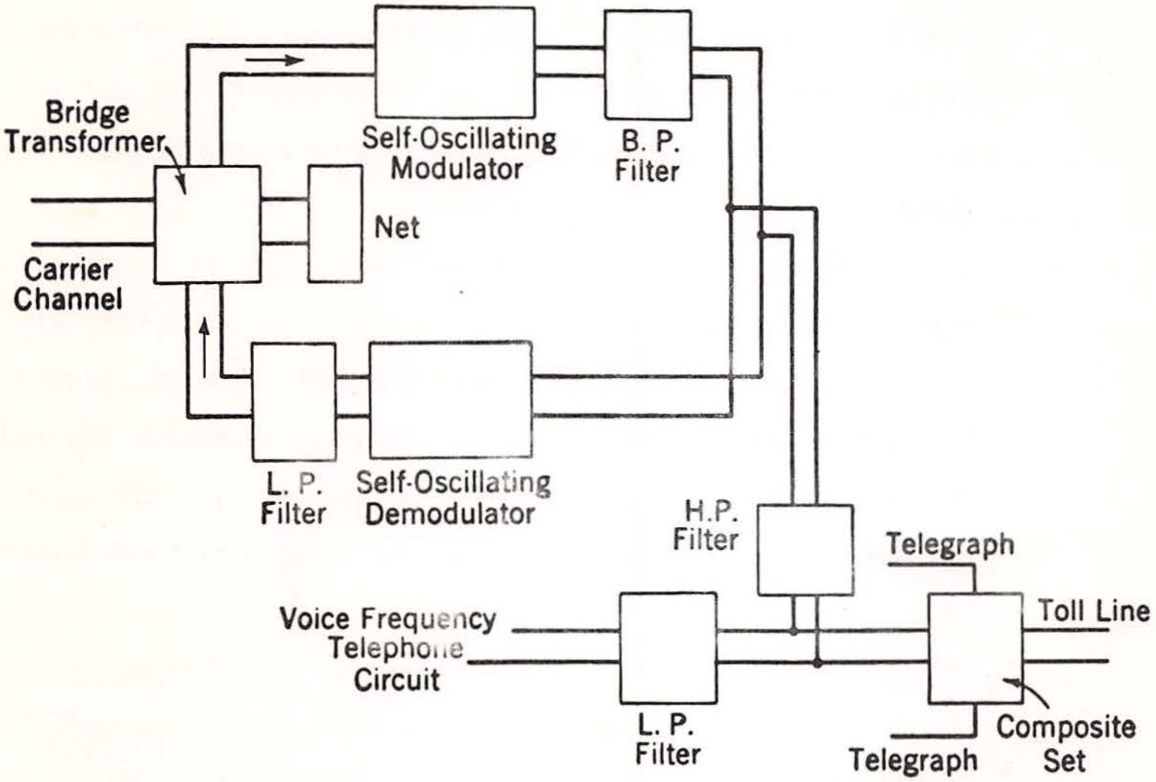
4. Type D Carrier System

The Type D system was developed for short open-wire line circuits about 100 miles long. It provides one two-way telephone circuit on a pair of wires in addition to the voice-frequency circuit. It uses single-sideband transmission with the carrier suppressed, and different frequencies are used for opposite directions of transmission, the lower sidebands


Mod
Band Filter
West Terminal
1
Dem.
Band Filter
Mod.
Trans. Amp.
Pilot Osc.
2
Dir. Filter
Dem.
Band Filter
Mod.
Rec. Amp.
Pilot Ind.
3
Dem.
Band Filter
H P Filter
Line Filter
To Composite Set
4
L P Filter
Line
Carrier Repeater
Dir. Filter
W to E Amp.
Dir. Filter
EQ
Pilot Ind.
EQ
Dir. Filter
E to W Amp.
Dir. Filter
H P Filter
H P Filter
Voice Repeater
L P Filter
L P Filter
Line
Band Filter
Mod.
East Terminal
1
Trans. Amp.
Pilot Osc.
Dem.
Band Filter
Mod.
Dir. Filter
2
Dem.
Band Filter
Pilot Ind.
Rec. Amp.
Mod.
3
Band Filter
Dem.
H P Filter
Line Filter
To Composite Set
4
L P Filter

Schematic diagram of a Type C carrier telephone system, and of carrier and voice-frequency equipment at a repeater station.

of carriers at 10.3 and 6.87 kilocycles. This system is low in first cost and in maintenance, economical for lines about 100 miles long. A later or Type DA system, using a transmitting amplifier, was developed to extend the length of the circuit to about 200 miles.


Bridge Transformer
Carrier Channel
Self-Oscillating Modulator
B. P. Filter
Net
L. P. Filter
Self-Oscillating Demodulator
H.P. Filter
Telegraph
Toll Line
Voice Frequency Telephone Circuit
L. P. Filter
Composite Set
Telegraph

Simplified diagram of a Type D carrier telephone system.

5. Type E Carrier System

The Type E is a single-channel system developed for power lines. It transmits a single sideband with the carrier suppressed. With the aid of voice-frequency switching, the same frequency band is used for both directions of transmission. The carrier band may be placed anywhere between 50 and 150 kilocycles.

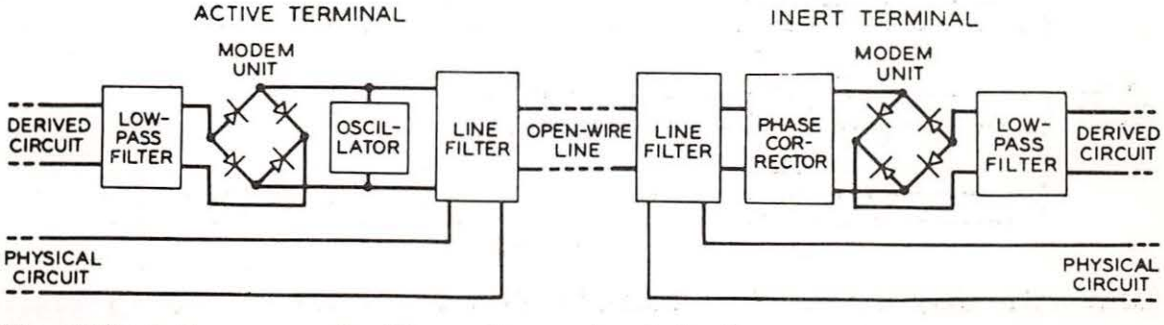
The essentials of carrier-current communication over power lines are the same as over telephone lines. One of the most difficult problems was that of coupling the carrier system to the high-voltage power line. The mutual capacitance between a long "antenna" wire and the power line was first used, but high-voltage coupling condensers are now usually used.

6. Type F Carrier System

Type F, or CF, was the temporary designation that was given to a single-channel system in which Type C equipment was used.

7. Type G Carrier System

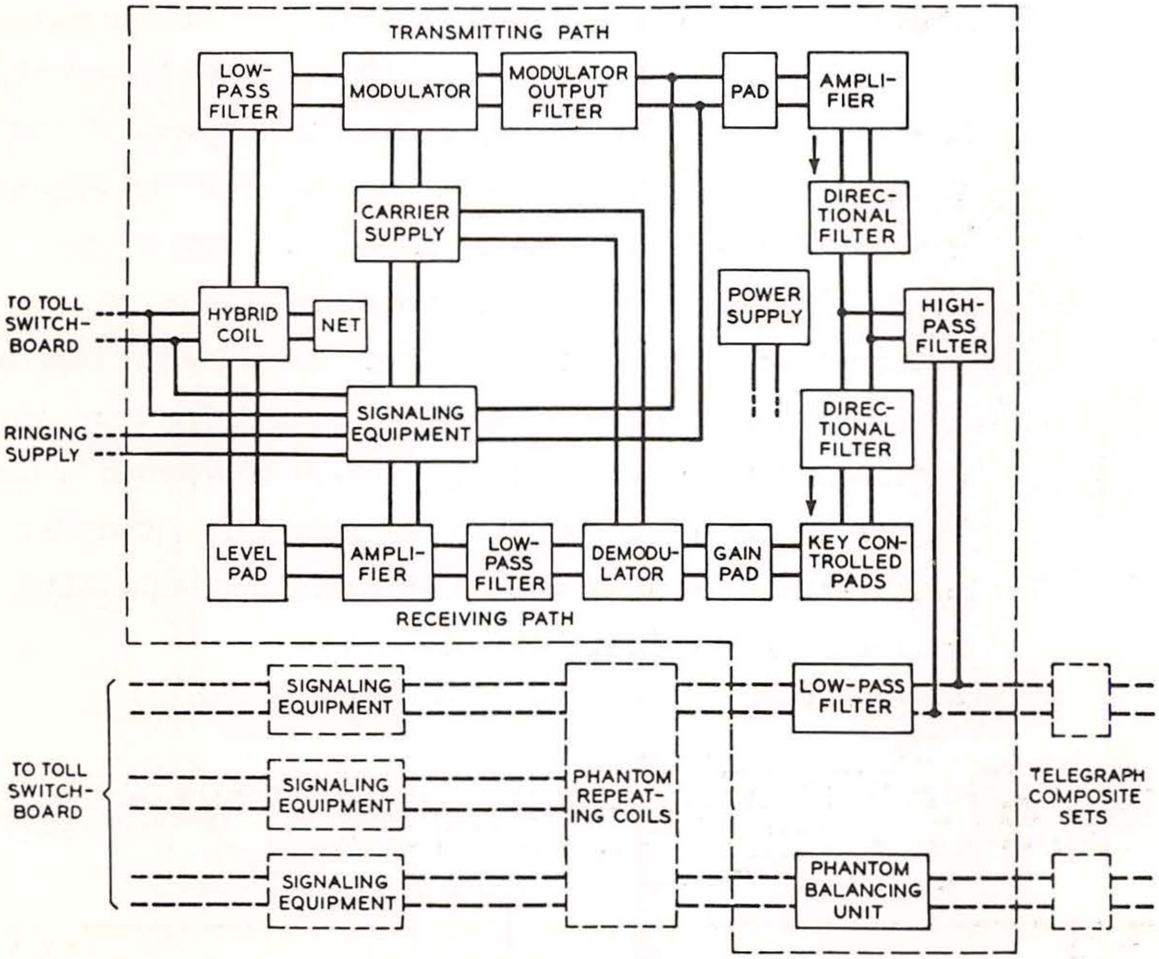
The Type G system was developed for use on open-wire lines over short distances, approximately 25 miles. It provides a single telephone channel in addition to the voice frequency channel. The carrier frequency is generated only at one terminal, known as the "active" terminal. The carrier and both sidebands are transmitted, and the same frequencies are used for both directions of transmission. The frequency band is between 6.5 and 14.1 kilocycles. Power is supplied by the "active" terminal. No power is required at the distant terminal, which is made up of inert elements, and is therefore referred to as the "inert" terminal.


ACTIVE TERMINAL
INERT TERMINAL
MODEM UNIT
MODEM UNIT
DERIVED CIRCUIT
LOW-PASS FILTER
OSCIL-LATOR
LINE FILTER
OPEN-WIRE LINE
LINE FILTER
PHASE COR-RECTOR
LOW-PASS FILTER
DERIVED CIRCUIT
PHYSICAL CIRCUIT
PHYSICAL CIRCUIT

Simplified diagram of a Type G carrier telephone system.

8. Type H Carrier System

This single-channel system is similar to the Types D and DA, but is more modern and economical. It is used on open-wire lines up to about 500 miles in length. It has approximately the same frequency allocation as the Type D system, with the difference, however, that the same carrier frequency of 7.15 kilocycles is used for both directions of transmission. The carrier is suppressed, the lower sideband is used for transmission in the west-to-east direction, and the upper sideband in the east-to-west direction. The H1 system includes a repeater as well as terminals.


TRANSMITTING PATH
LOW-PASS FILTER
MODULATOR
MODULATOR OUTPUT FILTER
PAD
AMPLIFIER
CARRIER SUPPLY
DIRECTIONAL FILTER
TO TOLL SWITCHBOARD
HYBRID COIL
NET
POWER SUPPLY
HIGH-PASS FILTER
SIGNALING EQUIPMENT
RINGING SUPPLY
DIRECTIONAL FILTER
LEVEL PAD
AMPLIFIER
LOW-PASS FILTER
DEMODULATOR
GAIN PAD
KEY CONTROLLED PADS
RECEIVING PATH
SIGNALING EQUIPMENT
LOW-PASS FILTER
TO TOLL SWITCHBOARD
SIGNALING EQUIPMENT
PHANTOM REPEATING COILS
TELEGRAPH COMPOSITE SETS
SIGNALING EQUIPMENT
PHANTOM BALANCING UNIT

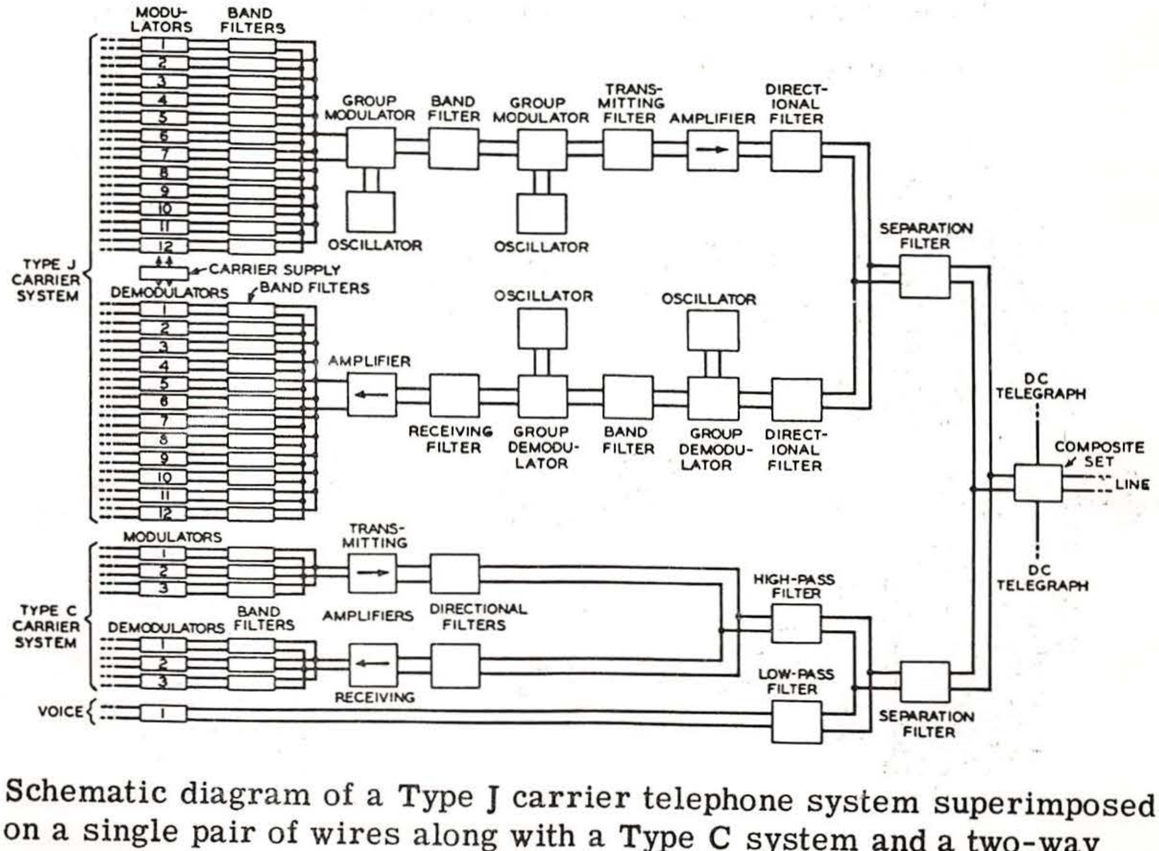
Schematic diagram of a terminal of a Type H carrier telephone system.

9. Type J Carrier System

The Type J system provides 12 two-way telephone circuits in a frequency band between 36 and 142 kilocycles. The low group of channels is transmitted at frequencies between 36 and 84 kilocycles in the west-to-east direction and the high group of channels at frequencies between 92 and 142 kilocycles in the east-to-west direction.

Repeater stations are located about 50 miles apart.

The frequency allocation is such that the Type J can be operated on the same pair of line wires with the Type C. With a J system, a C system, and a voice circuit, a total of 16 telephone circuits may be obtained on one pair of line wires.

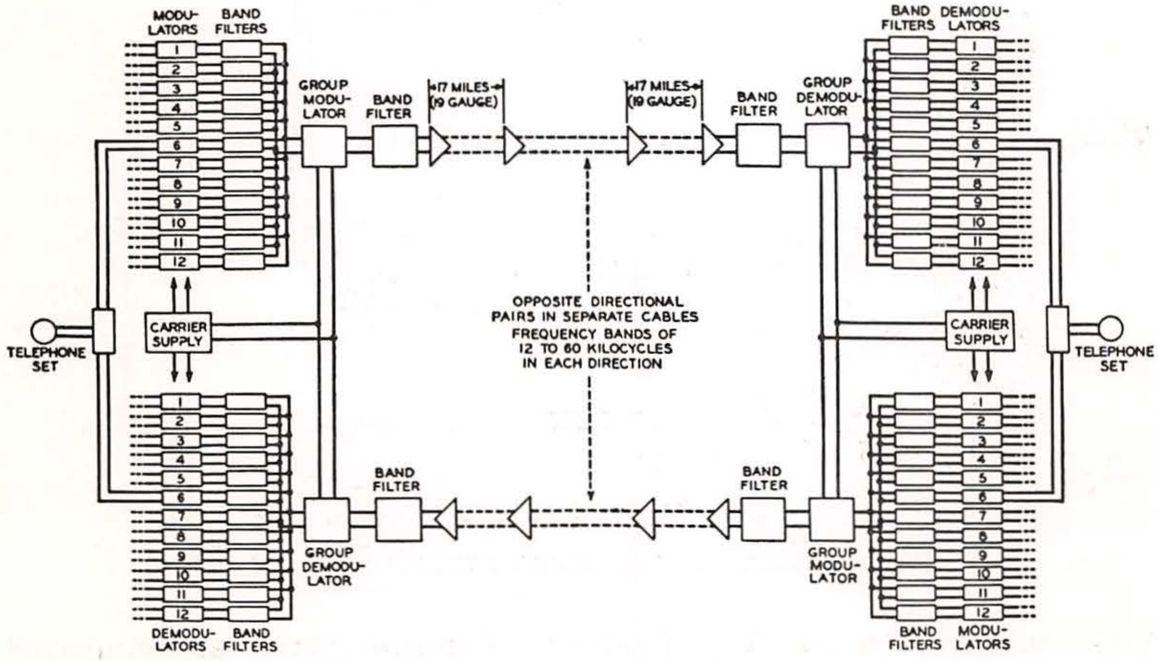

MODULATORS
BAND FILTERS
1
2
3
4
5
6
7
8
9
10
11
12
GROUP MODULATOR
BAND FILTER
GROUP MODULATOR
TRANSMITTING FILTER
AMPLIFIER
DIRECTIONAL FILTER
OSCILLATOR
OSCILLATOR
SEPARATION FILTER
TYPE J CARRIER SYSTEM
CARRIER SUPPLY
DEMODULATORS
BAND FILTERS
OSCILLATOR
OSCILLATOR
AMPLIFIER
RECEIVING FILTER
GROUP DEMODULATOR
BAND FILTER
GROUP DEMODULATOR
DIRECTIONAL FILTER
DC TELEGRAPH
COMPOSITE SET
LINE
DC TELEGRAPH
MODULATORS
TRANSMITTING
HIGH-PASS FILTER
TYPE C CARRIER SYSTEM
DEMODULATORS
BAND FILTERS
AMPLIFIERS
DIRECTIONAL FILTERS
RECEIVING
LOW-PASS FILTER
SEPARATION FILTER
VOICE

Schematic diagram of a Type J carrier telephone system superimposed on a single pair of wires along with a Type C system and a two-way voice circuit.

10. Type K Carrier System

The Type K system has been developed for application to toll cables. This application has been difficult because of the very high attenuation encountered. Several developments in recent years have helped to overcome this problem and give the required stability with low distortion; the feedback type of amplifier; regulating means to compensate for variations in transmission over the frequency range occurring from temperature changes; means for balancing out the crosstalk between cable pairs.

The Type K provides 12 four-wire telephone channels in the frequency range between 12 and 60 kilocycles, using non-loaded pairs in separate cables for opposite directions of transmission. Voice channels cannot be provided on the same wires.


MODU-LATORS
BAND FILTERS
1
2
3
4
5
6
7
8
9
10
11
12
GROUP MODU-LATOR
BAND FILTER
17 MILES (19 GAUGE)
17 MILES (19 GAUGE)
BAND FILTER
GROUP DEMODU-LATOR
BAND FILTERS
DEMODU-LATORS
TELEPHONE SET
CARRIER SUPPLY
OPPOSITE DIRECTIONAL PAIRS IN SEPARATE CABLES FREQUENCY BANDS OF 12 TO 60 KILOCYCLES IN EACH DIRECTION
CARRIER SUPPLY
TELEPHONE SET
BAND FILTER
BAND FILTER
GROUP DEMODU-LATOR
GROUP MODU-LATOR
DEMODU-LATORS
BAND FILTERS
BAND FILTERS
MODU-LATORS

Schematic diagram of a Type K carrier telephone system for cables.

For further information on the carrier telephone systems, see the following references:

Bower, M. M. The Carrier Telephone Alphabet. Bell Laboratories Record, February, 1938, Vol. XVI, No. 6, pp. 208-212.

Albert, Arthur L. Electrical Communication, Chapter XIV, John Wiley and Sons.

Affel, H. A., Demarest, C. S., and Green, C. W. Carrier Systems on Long Distance Telephone Lines. Bell System Technical Journal, July, 1928, Vol. 7, No. 3, pp. 564-629.

Black, H. S., Almquist, M. L., and Ilgenfritz, L. M. Carrier Telephone System for Short Toll Circuits. A.I.E.E. Transactions, January, 1929, Vol. 48, pp. 117-139.

Dickieson, A. C. The Type H Carrier Telephone System. Bell Laboratories Record, November, 1937, Vol. XVI, No. 3, pp. 76-79.

Jordan, H. G. A One-Tube Carrier System. Bell Laboratories Record, August, 1936, Vol. XIV, No. 12, pp. 393-396.

Blessing, E. C. Modulation in the G-1 Carrier System. Bell Laboratories Record, March, 1937, Vol. XV, No. 7, pp. 210-215.

Fisher, H. J., Almquist, M. L., and Mills, R. H. A New Single Channel Carrier Telephone System. Bell System Technical Journal, January, 1938, Vol. 17, No. 1.

Kendall, B. W., and Affel, H. A. A Twelve-Channel Carrier Telephone System for Open-Wire Lines. Bell System Technical Journal, January, 1939, Vol. 18, No. 1.

In a forthcoming issue we will discuss "What Affects Transmission of Carrier".

* * *

Birthdays of the Month

This issue features the biographies of Messrs. Charles, Dower, Green, Guthrie, Hunt, Reilly, and Swenson, who celebrate their birthdays in June.

T. N. Charles, signal and electrical superintendent, Southern, with headquarters in Charlotte, N. C., was born June 1, 1878, near Charleston, Tenn. He entered railway service April 10, 1899, as a signalman in the repair shop of the C. N. O. and T. P. (now part of the Southern system). On January 1, 1900 he worked in a construction gang as signalman, becoming construction foreman on March 1, 1901; maintenance foreman on April 1, 1902; signal supervisor on May 1, 1905. In 1918 he was promoted to chief signal and electrical inspector and in 1920 assistant engineer. On February 1, 1936, he was appointed signal and electrical superintendent.

David W. Dower, assistant signal engineer, Southern Pacific, with headquarters in San Francisco, Calif., was born in Nevada City, Calif., June 14, 1886. He entered the service of the Southern Pacific in 1905 in the signal department and has since been employed continuously in that department.

Rufus E. Green, assistant signal and electrical engineer, Michigan Central, with headquarters in Detroit, Mich., was born in Taylor, Ontario, June 10, 1881. He entered railroad service May 1, 1900 as laborer in the signal department of the Michigan Central. His subsequent career: November 1, 1900, batteryman, signal department, same road; December 20, 1901, signal inspector; October 1, 1903, signal foreman; October 15, 1904, foreman, signal department, St. Louis Terminal; October 15, 1905, foreman, Union Switch and Signal Co.; October 5, 1907, assistant signal supervisor, Michigan Central; August 1, 1909, signal supervisor. On July 1, 1912, he was appointed assistant signal engineer and on June 1, 1938 he was promoted to assistant signal and electrical engineer.

Lindsay Alexander Guthrie, signal engineer, Western Region, Canadian National, with headquarters in Winnipeg, Manitoba, was born in Woodlands, Manitoba, June 19, 1884. He entered railroad service with the C. N. R., September, 1914, as a carpenter in the bridge and building department at Winnipeg. From December, 1915, to August, 1917, he was signal maintainer in the maintenance of way department. In August, 1917, he advanced to signal inspector; in May, 1927, to acting signal engineer, and in November, 1929, to signal engineer, Western Region.

Adlai Stevenson Hunt, chief engineer communications and signals, Baltimore and Ohio, with headquarters in Baltimore, Md., was born in Marion, Ill., June 10, 1892. He entered railway service as a telegraph operator in an interlocking tower on the A.T. & S.F., at Dallas, Texas. Later he worked on signal construction on the C.R.I. & P., also on the construction of automatic signals on the Trinity and Brazos Valley. After the completion of this project, he was employed by the Western Union Telegraph as a switchboard installer, remaining with this company in various capacities, including equipment supervisor until 1936, at which time he was appointed superintendent of telegraph on the D. & R.G.W. in Denver, Colo. On January 1, 1944, Mr. Hunt was appointed superintendent of telegraph on the B. & O., and in July of the same year, general superintendent communications. He was appointed chief engineer communications and signals in July, 1945.

Albert Reilly, signal engineer, Delaware, Lackawanna, and Western, with headquarters in Hoboken, N. J., was born in Paterson, N. J., June 25, 1884. He entered railway service with the D.L. & W. as signal helper in January, 1901. Later in the same year he was promoted to batteryman. In 1903 he was wireman on signal construction, and, in 1905, he was signal maintainer. In 1907 he was promoted to signal construction foreman, advancing to signal inspector in 1912. In 1913 he was assigned to designing circuits and estimating in the signal engineer's office. In 1917 he was promoted to general signal inspector, on September 1, 1923, assistant signal engineer, and in March, 1942, signal engineer.

C. R. Swenson, superintendent of telegraph and signals, Chicago, Rock Island and Pacific, with headquarters in Chicago, Ill., was born in Kasota, Minn., June 3, 1898. After the high school course in his home town, he took a four-year course in electrical engineering at the University of Minnesota. He entered railway service in 1922 with the Great Northern as signal helper, then as maintainer, and later foreman of signal construction. In 1926 he joined the Pennsylvania Railroad, installing automatic train control on the Columbus division. He was promoted to assistant foreman, then foreman, and, in 1935, inspector. In May, 1940, he was appointed supervisor of telegraph and signals on the Pennsylvania - Reading Seashore Lines, and the Atlantic Division of the Pennsylvania Railroad. In September, 1942, he was appointed superintendent telegraph and signals of the Rock Island.

* * *

Arthur Holden to West Coast

Arthur C. Holden, western manager, is leaving Chicago for residence on the Pacific Coast where he will continue to maintain contacts in that territory. Our best wishes go with him

* * *

Ernest Pink Retires

After nearly forty years of steady service with us, Ernest Pink, our assistant treasurer retired April 30. Born in Galt, Ontario, Canada, February 14, 1876, he attended public school in his home town, later coming over to Rochester, where he completed a business course at the Rochester Business Institute. His first job was as clerk in Sibley's department store in 1888, where he advanced to the position of bookkeeper. In 1902 he joined Art-in-Buttons, Inc., a Rochester firm, and for four years was engaged in purchasing. He came with us in 1907 as bookkeeper, advancing to auditor and assistant treasurer.

A thoughtful, quiet man with a friendly manner which draws everyone to him, he will be missed by all in G-R-S who came to know him. We wish him much happiness in his retirement.

* * *

Richard Gardner Appointed Assistant Treasurer

Richard K. Gardner succeeds Ernest Pink as assistant treasurer of our company. Born in Troy, N. Y., June 14, 1907, he attended Lawrenceville school and graduated from Williams College in 1932. In 1933 he joined Clarke, Sinsabaugh and Co. as assistant treasurer, later senior research specialist. When this company merged with Scudder, Stevens and Clark, financial consultants, he became account executive. He served in the U.S. Army Air Forces from 1943 to 1945, as contract terminations negotiator, coming with our organization upon discharge.

A welcoming hand to you, Dick, and best wishes for a happy future.

* * *

Louis Freed Joins Chicago

Louis T. Freed, formerly senior circuit engineer, C.B. & Q., joins our Chicago office in the capacity of sales engineer. Born in Albia, Iowa, July 1, 1908, he attended the grade and high schools of his birthplace, later taking correspondence courses in electrical engineering and railway signaling. He entered railroad service with the C.B. & Q. on June 1, 1926; was promoted to maintainer, November, 1929; draftsman in the signal engineer's office, Chicago, November, 1939; circuit engineer, January, 1943, and senior circuit engineer, March 1, 1945.

Welcome, Louis. Here's wishing you the best of everything.

* * *

GENERAL RAILWAY SIGNAL COMPANY

Calculation of the Length of Passing Sidings

Of interest to C.T.C. engineers and students will be the new G-R-S pamphlet (number 635) entitled "G-R-S Formulas for Length of Sidings and Margin for Non-Stop Meets". The material contained in this pamphlet has been prepared by our Mr. Robert M. Phinney, Engineer of Train Operations, after years of research and study on the subject. The information is to be sent to the A.A.R. Signal Section, Committee I, Sub-committee D, all members, including A. M. Crawford, C. A. Mitchell, E. W. Reich, R. E. Taylor, J. S. Webb, R. H. C. Balliet, W. N. Hartman, B. T. Anderson, S. W. Freeman, S. E. Gillespie, and L. C. Ritterbush. Copies may be obtained from the Advertising Department.

After developing the basic formulas, Mr. Phinney goes on to show how the length of a siding can be shortened by the use of "preconditioning" at the turnouts, thus effecting large dollar savings. By preconditioning is meant the storing of a switch control while switch locking is in effect.

At a cost of 10 dollars per linear foot of siding track (an arbitrary figure), the following is the saving for each second of switch operating time lessened:

Speed of train on siding	For each second saved in switch operating time	
	Length of siding track saved	Cost of siding track saved
5 mph.	14.7 feet	$ 147
10	29.4	294
15	44.1	441
20	58.8	588
25	73.5	735
30	88.2	882
35	102.0	1020

* * *

Approach Indication Circuit

For the C & NW on Contract CM5326 for a relay interlocking at East St. Paul, Minn. the accompanying indication circuits were devised and tested. The circuits show the control for two indication lights in the tower over one wire and the signal common, and for the ringing of a bell over a second wire and the same signal common.

A. Light Indication Circuit

This circuit consists essentially of two center-tapped half-wave rectifiers, one in the tower and one in the field housing. The tower rectifier is connected to the indication lights and to the indication line ABTE. The field rectifier is tied to contacts on the track relays AT and BT and to the secondary of the indication transformer. When relay AT is deenergized, the lower legs of both rectifiers are connected and half-wave a-c. lights the ATE. Likewise, when relay BT is deenergized, the upper legs of both rectifiers are connected and the BTE is lighted. If both track relays AT and BT are deenergized, both lights are lighted through the tower rectifier directly from the transformer secondary.

B. Bell Indication Circuit

The discharge of a capacitor is used to energize the bell relay AXR. With both track relays energized both capacitors are charged by direct current supplied from the field rectifier (approximately 27 volts). When either track relay AT or BT is deenergized, the respective capacitor discharges over line wires AX and Z-COM through the bell relay AXR. The single-stroke bell operates on local battery through a front contact on relay AXR.

NOTES IN CIRCUIT BELOW

NOTE 1:- Maximum line resistance for 12 (6-6) center-tapped lead cells:

Number of Relays To Be Indicated	Allowable Resistance Each Line Conductor
4	20 ohms
6	15 "
8	10 "
10	5 "

NOTE 2:- 12 cells lead, 24-volt field battery for operating light indication and bell relay.

NOTE 3:- 4 cells lead, 7-volt minimum tower battery for operating bell.

DEVICES IN CIRCUIT BELOW

RECT - Rectifier 54941-119 Gr. 1
Type BB 1/2, 27 V., 0.150A D-c.

BELL - Bell Comp.
G.R.S. Single Stroke, 20 ohms
High Pitch 56525 Gr. 1
Low Pitch 56525 Gr. 2

TE - Lamp 52879-1
Tel. Type 12 V. 0.110A

LI - Arrester Comp. 56947 Gr. 2
Rare Gas Shunt. 30 V. D-c.

L2 - Lightning Arrester
Clear View 56937-5 Gr. 2

INT - Interrupter 57085 Gr. 4
Type B, DPDT Pole Changer
50 Watts, 24 V. D-C. 20 V. 60 Cy. A-C.

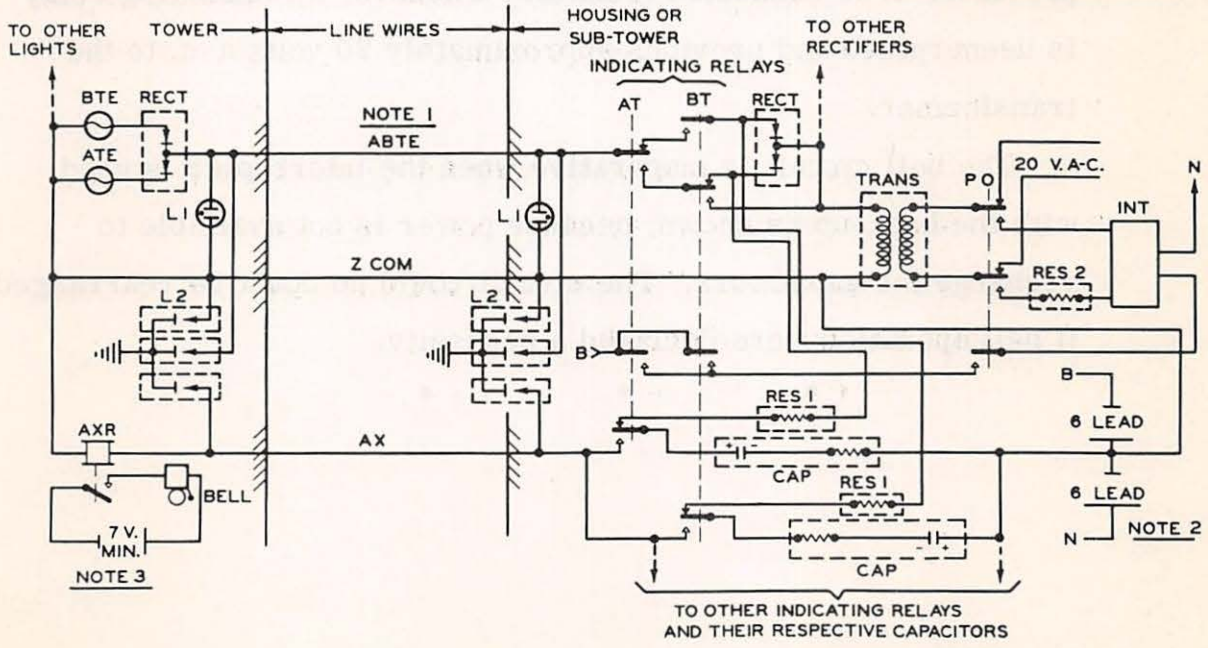
RES. 1 - Resistor Comp. 50482-8 Gr. 8, 50 ohms

CAP - Capacitor Comp. 47630 Gr. 1
1000 Mfds. 5 ohms

TRAN - Transformer 53715-4 Gr. 2
Type S, 24 (2-18-4) -24 (2-18-4)
Amus 13 AS -147

RES. 2 - Resistor Comp. 50482-8 Gr. 16
3 ohms

AXR - Relay 54250-17 Gr. 16
Type W, Size 2, Class E
4.25 ohms
or
53000-734 Gr. 1
Type B, Size 1
4 ohms 4F, 2B



TO OTHER LIGHTS
TOWER
LINE WIRES
HOUSING OR SUB-TOWER
TO OTHER RECTIFIERS
INDICATING RELAYS
BTE
RECT
ATE
NOTE 1
ABTE
AT
BT
RECT
TRANS
PO
20 V. A-C.
N
INT
LI
LI
Z COM
RES 2
L2
L2
B
B
RES I
6 LEAD
AXR
AX
CAP
RES I
6 LEAD
BELL
7 V. MIN.
N
NOTE 2
NOTE 3
CAP
TO OTHER INDICATING RELAYS AND THEIR RESPECTIVE CAPACITORS

Typical circuit (SK 6549) for light and bell indications. Signal control common and one additional light control line wire for each pair of indicating relays and one additional bell control line wire for all indicating relays.

The 50-ohm resistors in the capacitor charging circuits are for limiting the charging current drag on the rectifier. The 5-ohm resistors in series with the capacitors are used to limit the current that flows through a discharged capacitor from a charged capacitor when more than one track relay is deenergized, thus insuring enough energy to pick up relay **AXR.** Note 1 on the circuit shows the maximum allowable line resistance for a given number of track relays for satisfactory operation.

C. Lightning Surge Protection

Since rectifiers are vulnerable to lightning and other line surges, the three lines are protected with lightning arresters L2 connected to ground; and lines ABTE and Z-COM are protected by gas-filled shunt arresters L1. A surge over lines AX and Z-COM may cause the bell to ring.

D. Power Transfer

To insure operation of the lights when the a-c. power supply fails, an interrupter (or inverter) of the vibrating reed type is provided. It is connected to battery whenever an indicating relay is deenergized and provides approximately 20 volts a-c. to the transformer.

The bell circuit is inoperative when the interrupter is used with the hook-up as shown, because power is not available to recharge the capacitors. The circuit could no doubt be rearranged if bell operation were declared a necessity.

* * *

New Acceptance Test for Silicon Steel Improves Product Uniformity

All incoming steel bar stock which is made into cores for relays and other electro-magnetic devices must now pass an acceptance test for residual magnetism.

A section of the bar stock is cut off, annealed, then brought under the magnetizing influence of an energized coil. A test is then made for residual magnetism in the bar of steel.

After many years of experience in fabricating cores we have discovered that, in addition to uniform composition, the history of a piece of steel, up to the time we receive it, has an important bearing on the magnetic properties of the finished core. If we could be sure that each shipment of steel we receive has the same chemical composition, the same grain growth, and was rolled or drawn under identical conditions, we would have greater assurance that the cores would possess uniform magnetic properties.

Since the mills cannot commercially produce steel of such uniformity, the residual test on an annealed bar is a reliable indicator of the magnetic qualities which will develop in our cores after annealing.

After our relay cores are fabricated, they are annealed and checked for residual magnetism. If values do not meet standards, the cores are reannealed and rechecked.

All of which points to the fact that these tests make possible more uniform relay cores, with fewer rejections in the final stages of manufacture.

* * *

Button Added to Contacts of Switch Circuit Controllers

Model 7 switch circuit controllers have had a recent addition made in the form of buttons added to the contact fingers. These buttons, as shown in the accompanying drawing, are rivetted to the fingers near the silver contact tip. They are installed only on the fingers actuated by the two-position cams.

Without this button (or spacer), it was found that the upper roller would rub against the point of the cam and would wear because of cam movement caused by vibration.

The button prevents the finger itself from engaging with the fixed contact stop. Held away in this manner, the finger centers the rocker arm about the cam. A slight clearance between the cam and the rollers is thereby obtained without sacrificing sensitivity of finger response to cam movement.

* * *

Switch Control Circuit with Biased Neutral Relays

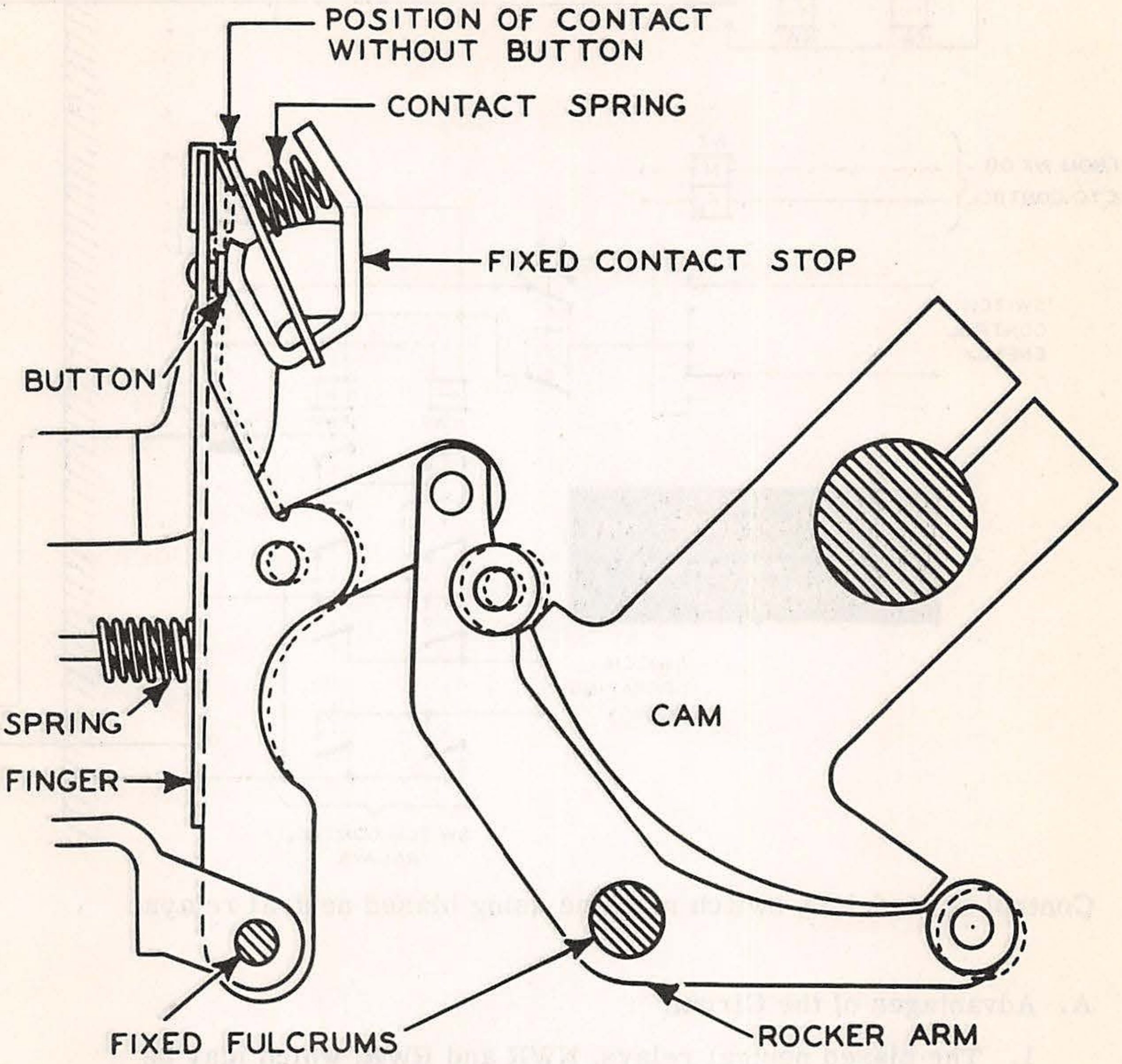
The accompanying diagram on pages 8 and 9 shows a typical cTc or NX type control circuit for a Model 5A switch machine using the new biased neutral relays for control and indication.

NWR, RWR, NWC and RWC are the biased neutral relays. They pick up when current flow is in the direction indicated by the arrows. Current applied in the opposite direction does not affect them. These relays are described in the November 1945 G-R-S News, pp. 11-19, and also in July 1946 G-R-S News, pp. 10-14.

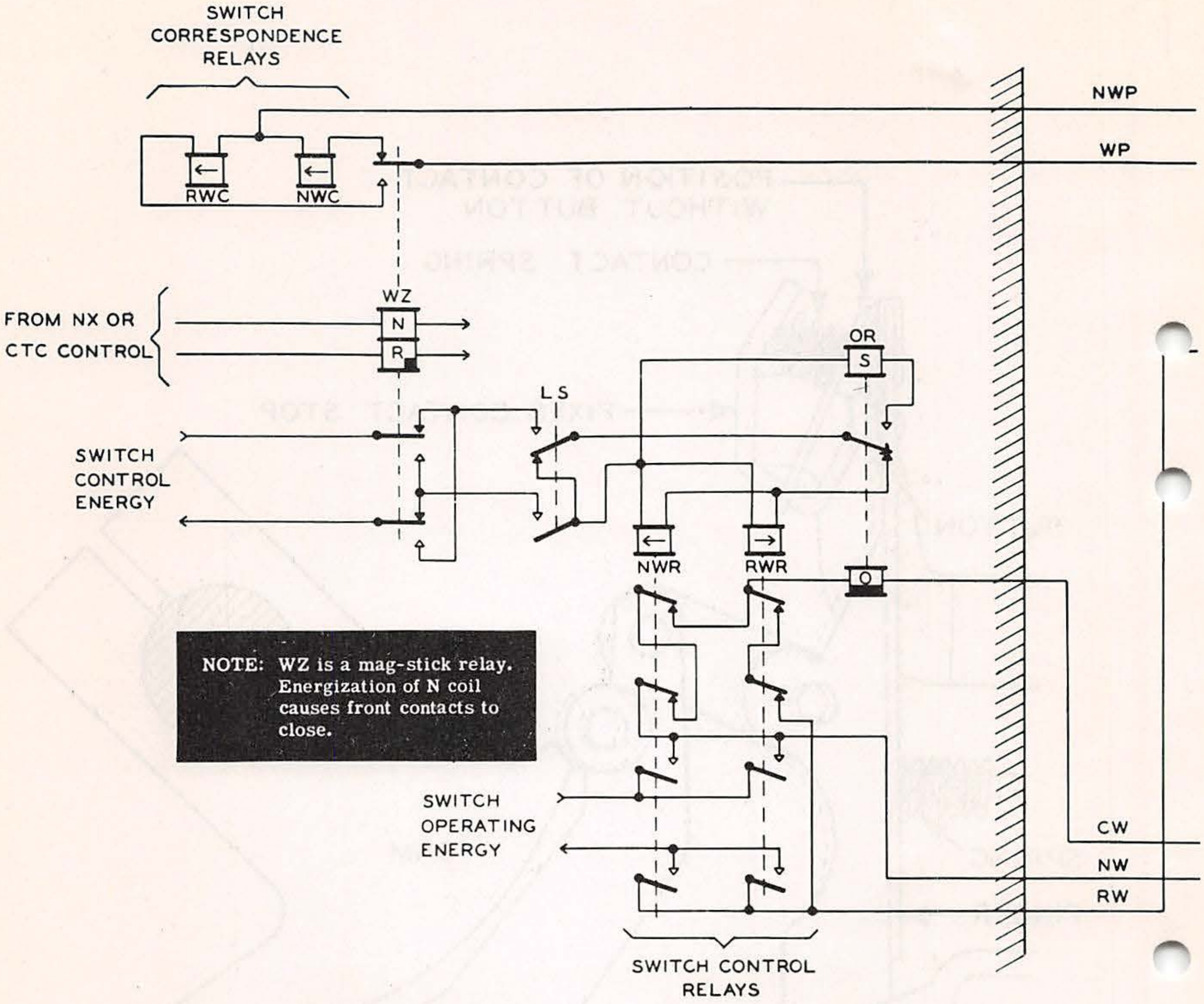
WZ is a mag-stick relay. It remains in the last position to which it is operated. When coil N is energized, WZ closes its front contacts. When coil R is energized, WZ closes its back contacts.

OR is an overload relay. O is the operating coil and S is the stick coil.

For a crossover, an NWR, an RWR, and an OR relay are required for each switch machine.


POSITION OF CONTACT WITHOUT BUTTON
CONTACT SPRING
FIXED CONTACT STOP
BUTTON
CAM
SPRING
FINGER
FIXED FULCRUMS
ROCKER ARM

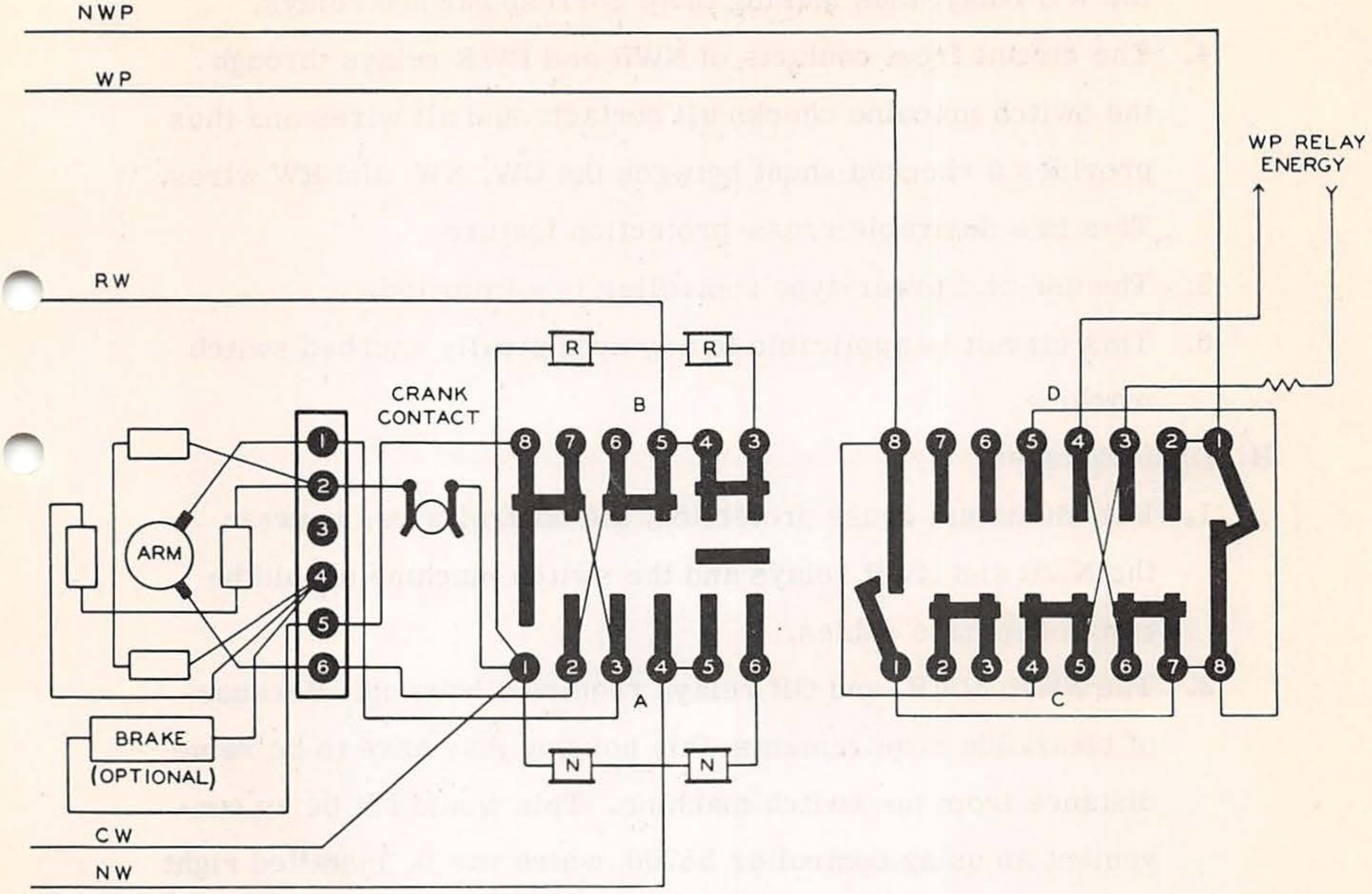
Button on fingers of switch circuit controllers act as spacers.


SWITCH CORRESPONDENCE RELAYS
RWC
NWC
NWP
WP
WZ
N
R
FROM NX OR CTC CONTROL
OR
S
LS
SWITCH CONTROL ENERGY
NWR
RWR
O
NOTE: WZ is a mag-stick relay. Energization of N coil causes front contacts to close.
SWITCH OPERATING ENERGY
CW
NW
RW
SWITCH CONTROL RELAYS

Control of Model 5A switch machine using biased neutral relays.

A. Advantages of the Circuit

1. The biased neutral relays, NWR and RWR, which may be Type K or Type B as desired, can be controlled directly over a two-wire polarized circuit, which is practically immune to false operation because of crosses.
2. This circuit provides for use of a Type K or a Type B self-contained, automatically-restoring overload relay. Operating


NWP
WP
WP RELAY ENERGY
RW
R
R
CRANK CONTACT
B
D
ARM
1
2
3
4
5
6
8 7 6 5 4 3
8 7 6 5 4 3 2 1
1 2 3 4 5 6
1 2 3 4 5 6 7 8
A
C
N
N
BRAKE (OPTIONAL)
CW
NW

For details on the contact operations of the pole changer and point detector, see Handbook 24 Figures 903 and 1103, and their accompanying descriptions.

energy for the switch machine always passes through coil O of overload relay OR. When an overload occurs, coil S of the overload relay will stick up until energy to it is momentarily interrupted by the pole-changing contacts of WZ. Note that energy to coil S is not only interrupted but is also pole-changed through the contacts of WZ. This assures dropaway of coil S regardless of the rapidity with which WZ may function.

3. Biased neutral relays NWC and RWC are controlled through the WZ relay, thus making them correspondence relays.
4. The circuit from contacts of NWR and RWR relays through the switch machine checks all contacts and all wires and thus provides a checked shunt between the CW, NW, and RW wires. This is a desirable cross-protection feature.
5. The use of a tower-type controller is eliminated.
6. This circuit is applicable to any dynamically snubbed switch machine.

B. Disadvantages

1. For maximum cross protection, the control wires between the NWR and RWR relays and the switch machine should be run in separate cables.
2. The NWR, RWR, and OR relays require a housing. Because of clearance requirements, this housing may have to be some distance from the switch machine. This would not be as convenient as using controller 58700, which can be installed right next to the switch machine

* * *

Monon President Sees Need for C.T.C. Everywhere

Most of us may have read his article already, but it is interesting to note that John W. Barriger, President, C.I. & L., sees an important place for C.T.C. in modern railroading. In the November 16 (Passenger Progress) issue of Railway Age, in his article entitled "Let's Give the Travel Market a REAL Test", Mr. Barriger writes: "- - -to give passenger service a real trial, we shall have to bid good-bye to the kind of slow and costly railroading which served the purpose well enough when the horse and buggy was our only competitor. We shall have to set a program of roadway improvements looking to the eventual elimination of all speed-restricting curvature and grades in excess of 0.5 per cent (except in mountain territory). We shall have to establish C.T.C. everywhere. . . ."

* * *

Donald Holdway Appointed Our Resident Engineer in São Paulo

It's with pleasure that we announce the appointment of Donald F. Holdway to the post of resident engineer with headquarters in São Paulo, Brazil.

Don comes to us with an interesting background of signaling experiences gained in Asia and Europe. Back in 1918 he was apprenticed with Messrs. W. K. L. Dickson, experimental engineers, in England. In 1925 he joined the Westinghouse Brake and Signal Co. in London, going out for them to India in 1930 in charge of signaling installation work at the Bombay Central Station on the Bombay, Baroda and Central Indian Railway.

Donald F. Holdway

In 1932 he shipped to the Polish State Railways, in charge of signaling installation at Warsaw Central Station, which work lasted for a year. From 1934 to 1938 he was in charge of various signaling jobs in Poland and Central Europe. When war clouds darkened Europe, he returned to England and took charge of the electrical research and development laboratory of Messrs. Westinghouse.

Born in London, England, July 23, 1902, of Frank and Emily

Holdway, Don attended St. Winifred's College and Rutlish College in Merton, then went on to London Polytechnic. He met his wife Krystyna while in Poland and was married in 1937. They have one daughter, Arianna, and make their home in Aclimação, São Paulo. Hobbies are photography and yachting.

* * *

GENERAL RAILWAY SIGNAL COMPANY

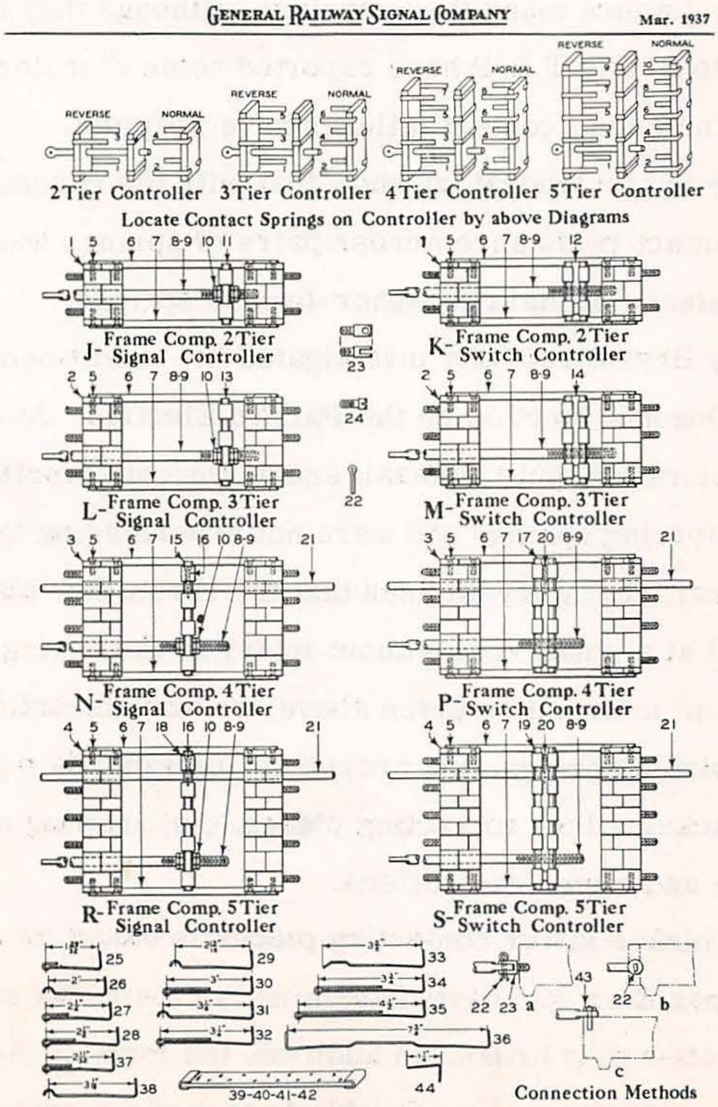
G-R-S NEWS

March 1947

Chrome-plated Contacts on Interlocker Circuit Controllers Discontinued

For a number of years we have been using chromium-plated contacts on high-voltage circuit controllers as illustrated on catalog plate G0409, where low voltage circuits are carried through contacts on these controllers.

PLATE G0409



General Railway Signal Company
Mar. 1937
REVERSE
NORMAL
2 Tier Controller
3 Tier Controller
4 Tier Controller
5 Tier Controller
Locate Contact Springs on Controller by above Diagrams
J-Frame Comp. 2 Tier Signal Controller
K-Frame Comp. 2 Tier Switch Controller
L-Frame Comp. 3 Tier Signal Controller
M-Frame Comp. 3 Tier Switch Controller
N-Frame Comp. 4 Tier Signal Controller
P-Frame Comp. 4 Tier Switch Controller
R-Frame Comp. 5 Tier Signal Controller
S-Frame Comp. 5 Tier Switch Controller
22
23
24
39-40-41-42
44
Connection Methods
a
b
c

Circuit Controllers—High Voltage
For Electric Interlocking Machines

After quite a large number of these contact springs had been tried out in actual service and reported as being satisfactory, their use was adopted.

In July 1941 we had a complaint from the Santa Fe regarding the blackening of these chromium-plated contacts on the Mission Tower machine. During 1946 we received complaints of the same nature from the Soo Lines and Union Pacific.

The NYC Lines East also recently reported experiencing excessively high contact resistance using these springs, although they did not report any discoloration. The T & P have reported some discoloration of springs, but apparently no actual contact failures have resulted.

Tests made in our laboratory show that with the chromium-plated springs, the contact resistance across pairs of springs was from 9 to 30 times the resistance of plain phosphor-bronze springs.

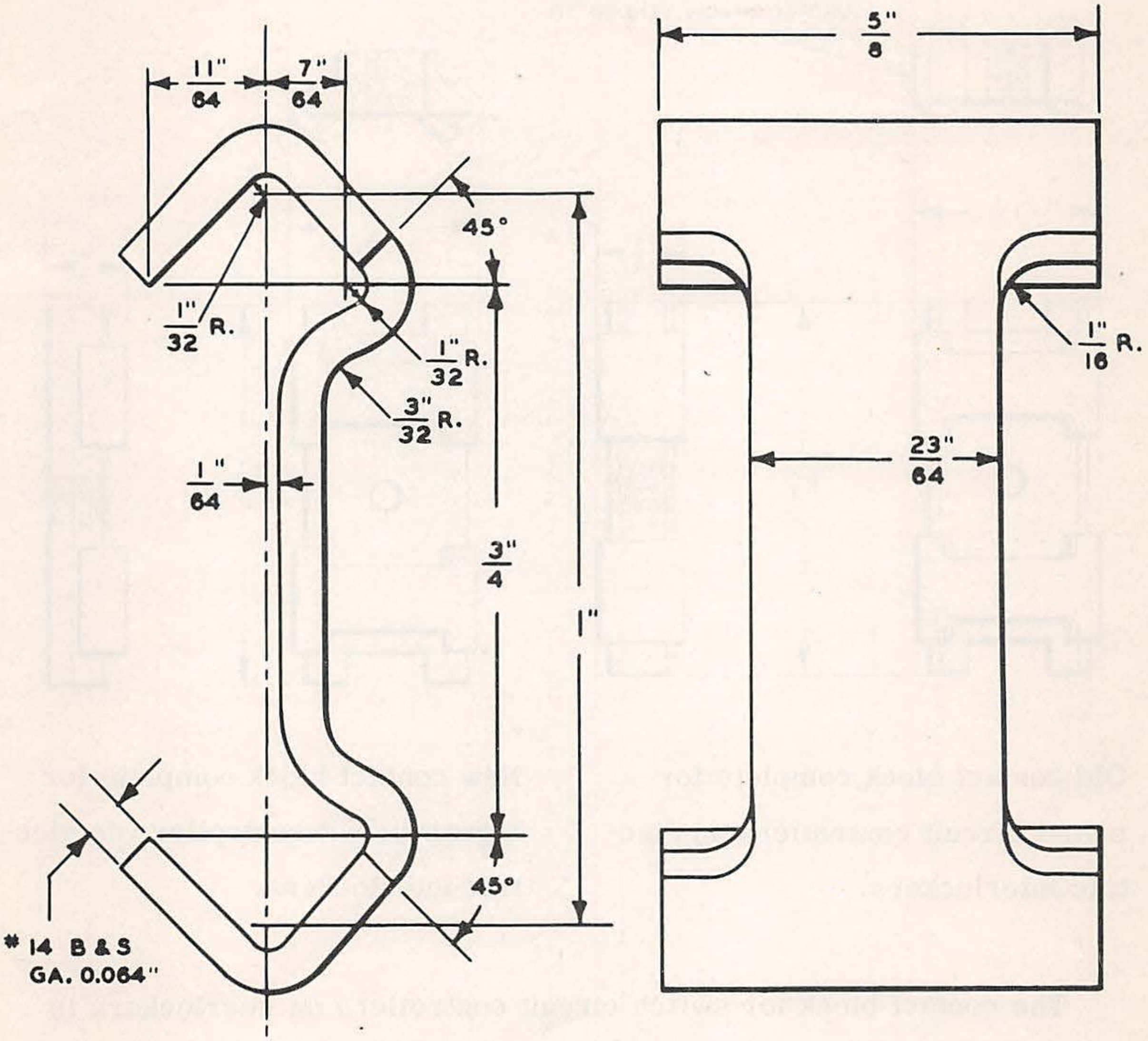
Mr. Stanley Bryant recently investigated the conditions at Mission Tower and at Oneonta Junction on the Pacific Electric. At Mission he found the discoloration quite general, and at Oneonta Junction the railroad had added reinforcing springs and were not experiencing failures.

Our chemical laboratory advises that the chromium-plated springs can be stripped at a small cost without injury to the spring itself.

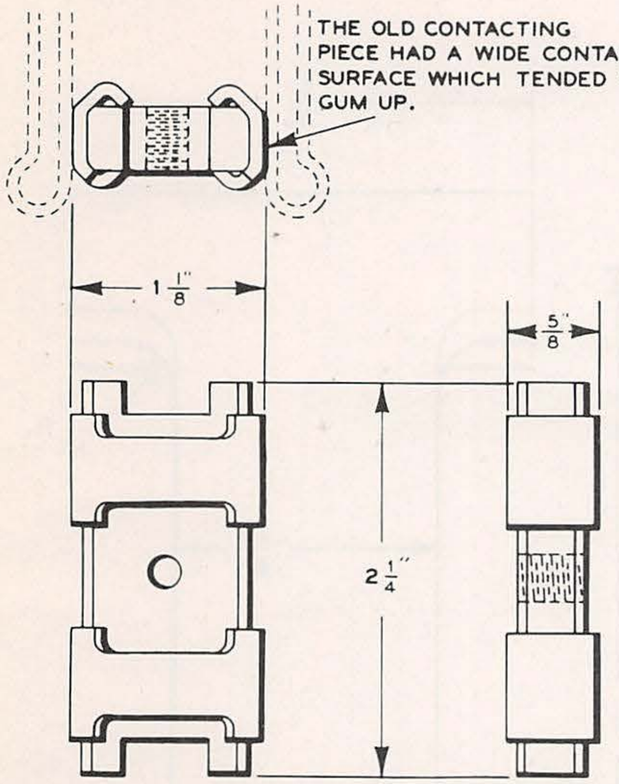
In view of the information given above, we are discontinuing the use of chromium-plated springs, and providing, instead, plain phosphor-bronze springs with nickel-silver contacting pieces, our drawing number 3255-1 for both switch and signal controllers.

The use of nickel-silver contacting pieces is based on the experience of the NYC Lines East who have determined to their own satisfaction that they are better than brass. In addition, the form of the new contacting pieces (see opposite page) is preferable to that of the original contacts.

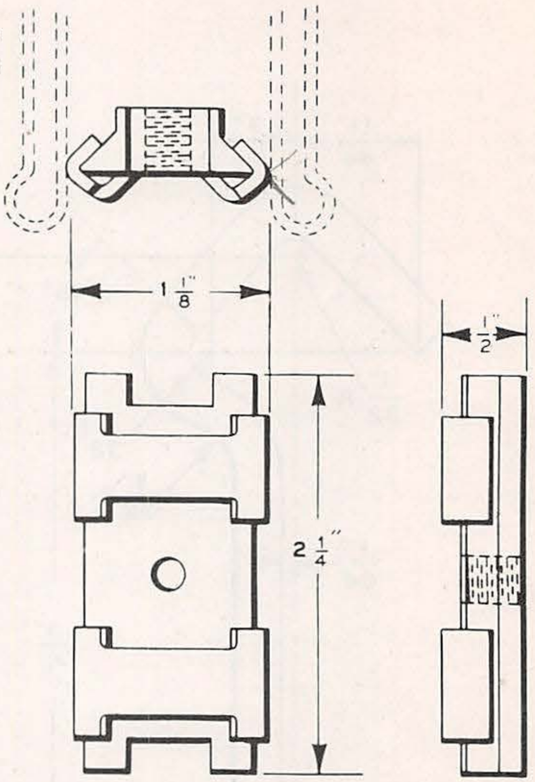
on signal controllers since they require less maintenance to keep the surfaces clean. The old and new signal circuit controller contacts are shown on the next page for comparison.


11"/64
7"/64
45°
1"/32 R.
1"/32 R.
3"/32 R.
1"/64
3"/4
1"
45°
#14 B & S GA. 0.064"
5"/8
1"/16 R.
23"/64

Formed contact 3255-1, nickel-silver, for contact blocks complete (3253-13 and -14) for circuit controllers used on electric interlockers.


THE OLD CONTACTING PIECE HAD A WIDE CONTACT SURFACE WHICH TENDED TO GUM UP.
1 1/8"
5/8"
2 1/4"

Old contact block complete for signal circuit controllers on electric interlockers.

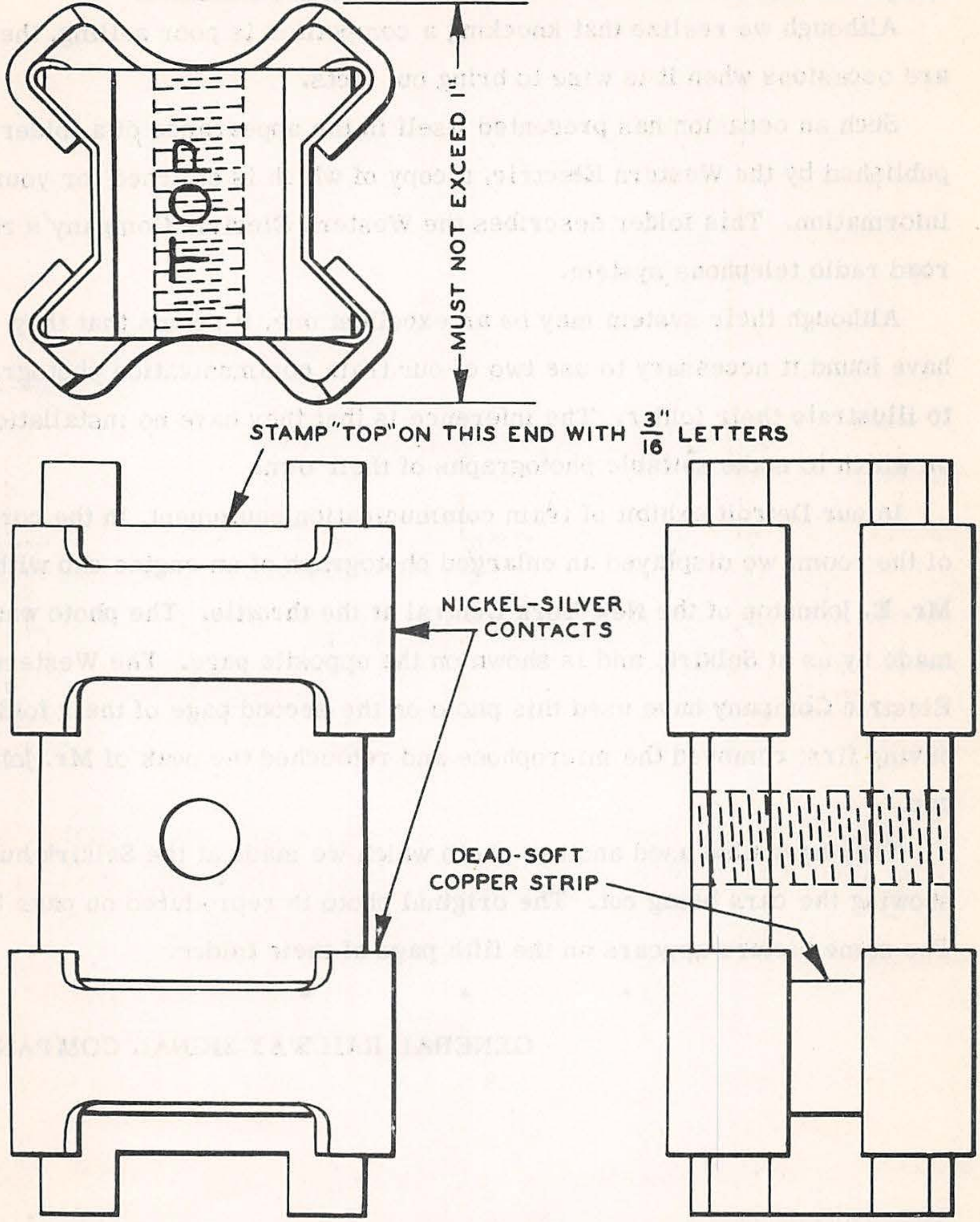


New contact block complete for signal circuit controllers on electric interlockers.

The contact block for switch circuit controllers on interlockers is shown on the opposite page. Note that the signal contact block is half the switch contact block.

It is not recommended that new contacts be applied to blocks in the field as this necessitates using a very special fixture. It will be found more satisfactory to purchase new contact blocks complete.

* * *


TOP
MUST NOT EXCEED 1"
STAMP "TOP" ON THIS END WITH 3/16" LETTERS
NICKEL-SILVER CONTACTS
DEAD-SOFT COPPER STRIP

Contact block complete (3253) for switch circuit controller on electric interlockers.

G-R-S Train Radio Photos Used to Sell Competitive System

Although we realize that knocking a competitor is poor selling, there are occasions when it is wise to bring out facts.

Such an occasion has presented itself in the appearance of a folder published by the Western Electric, a copy of which is attached for your information. This folder describes the Western Electric Company's railroad radio telephone system.

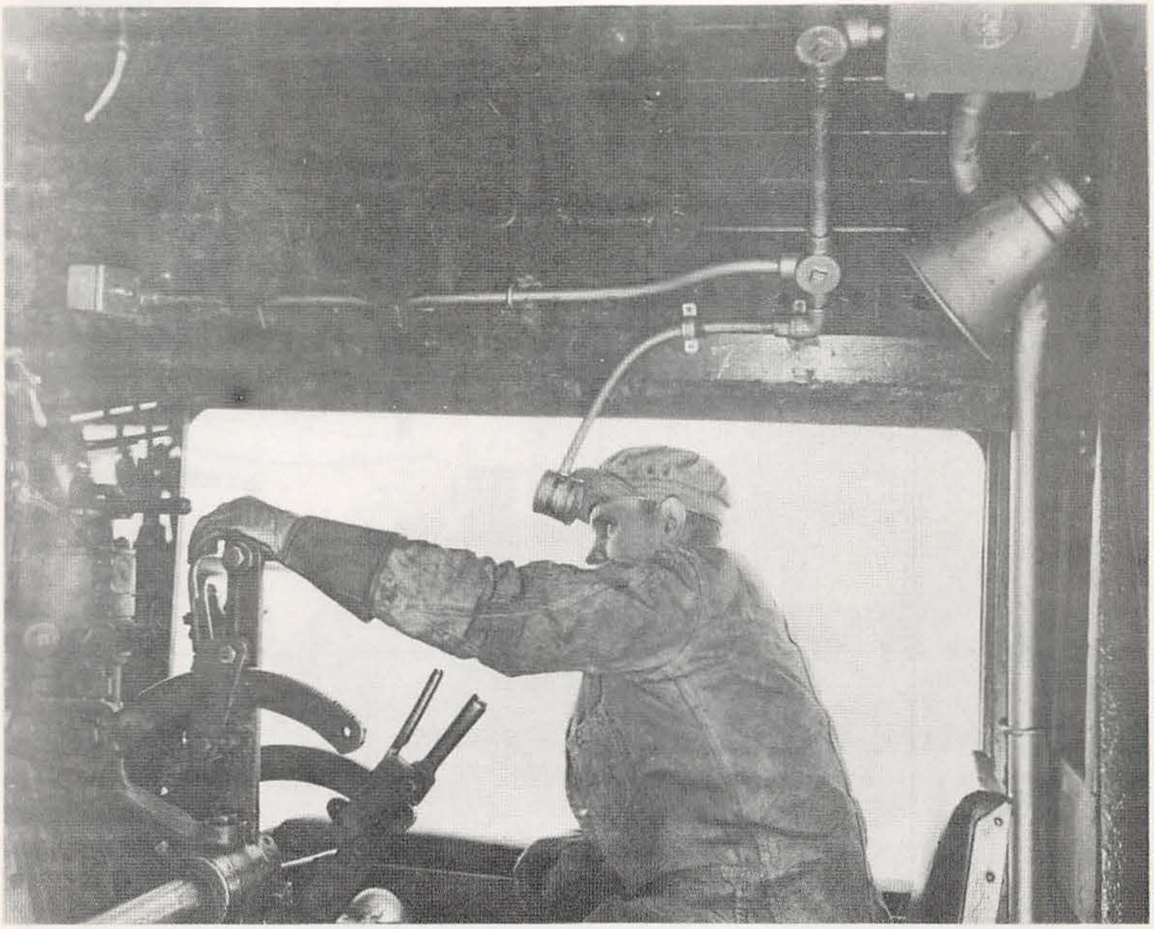
Although their system may be an excellent one, it seems that they have found it necessary to use two of our train communication photographs to illustrate their folder. The inference is that they have no installation on which to make suitable photographs of their own.

In our Detroit exhibit of train communication equipment, in the corner of the room, we displayed an enlarged photograph of an engine cab with Mr. E. Johnston of the New York Central at the throttle. The photo was made by us at Selkirk, and is shown on the opposite page. The Western Electric Company have used this photo on the second page of their folder, having first removed the microphone and retouched the peak of Mr. Johnston's cap.

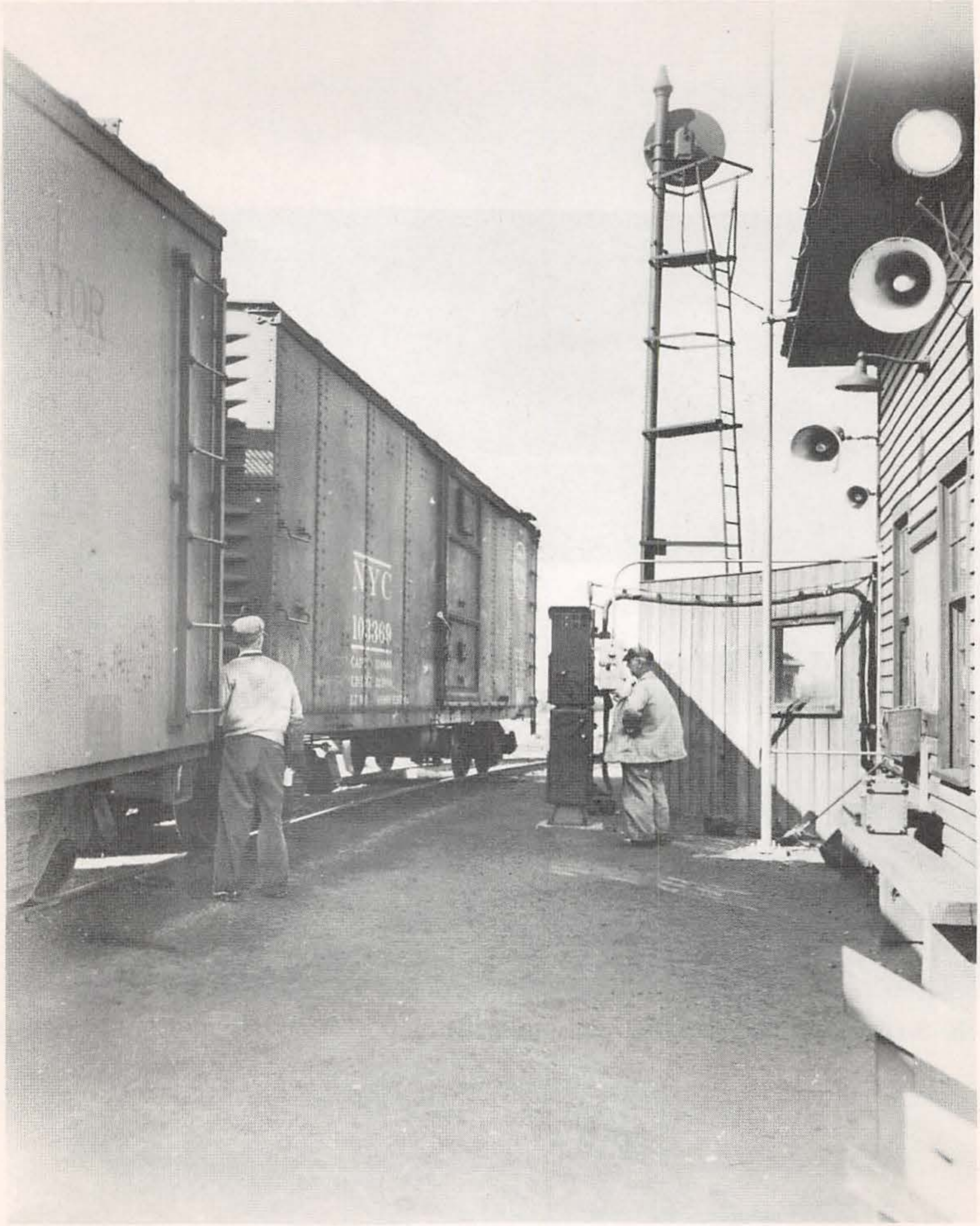
They have also used another photo which we made at the Selkirk hump showing the cars being cut. The original photo is reproduced on page 8. The same picture appears on the fifth page of their folder.

* * *

GENERAL RAILWAY SIGNAL COMPANY



G-R-S train communication equipment in cab of NYC locomotive at Selkirk.



At Selkirk hump on NYC, the cutting of cars is facilitated by G-R-S train communication.

Signaling Statistics, 1946

Based on the Statistical Issue of Railway Age, dated January 4, 1947, the following is a comparison of the signaling and the train communication systems furnished by the signal companies and put in service in 1946:

CENTRALIZED TRAFFIC CONTROL

	Union	GRS
Track-miles	904.2	238.6
No. of levers	583	184
Power switches	372	81
Signals	1,122	263

BLOCK SIGNALING

	Union	GRS
Track-miles	1,594.9	1,122.4
Signals	1,809	1,261

ALL-RELAY INTERLOCKING

	Union	GRS
Signals	447	374
Switches	236	178

AUTOMATIC INTERLOCKING

	Union	GRS
Signals	71	53

CAR RETARDERS

	Union	GRS
Tracks	41	-
Retarders	18	-
Rail-feet retarders	1239	-
Switches	43	-
Track circuits	43	-
Skates	30	-
No. of towers and control mach.	3	-

TRAIN COMMUNICATION - ROAD

	Union	GRS
Locomotives	300	-
Cabooses, etc.	100	-
Wayside	16	-

TRAIN COMMUNICATION - YARD

	Union	GRS
Locomotives	14	-
Wayside	4	-

* * *

Available Magazine Reprints on Railway Signaling

The following is a complete list to date of the magazine reprints which are available. Copies can be obtained from the Advertising Department.

Ry. Age	Apr. 12, 1924	What Is the Cost of Freight Train Delays?
Ry. Sig.	Mar. 1928	B & M Installs New Type of G-R-S Car Retarders
Ry. Age	Apr. 14, 1928	Dispatcher Signaling System Operates Through Sleet Storm
Ry. Sig.	June 1929	Engineering Research Improves Signaling Devices and Systems
Ry Age	June 28, 1930	Cleveland Union Terminals
Ry. Sig.	June 1931	Centralized Traffic Control on the Peoria & Pekin Union
Ry. Sig.	Feb. 1932	Centralized Traffic Control Installed on the Baltimore & Ohio
Ry. Sig.	Jan. 1933	Simplified Interlocking Installed at the Dayton Union Term.
Ry. Sig.	Apr. 1934	Signaling of the New York Subways
Exide News	Spring 1935	American Railroad Signals (Historical)
Ry. Sig.	Nov. 1936	All-Relay Interlocking on the N Y.C. at Syracuse, N.Y.
Ry. Sig.	Oct. 1937	cTc on the D. & R.G.W.
Sig. Jou.	Jan. 1938	NX Interlocking Simplifies Train Directing at Busy Junction
Sig. Jou.	Jan. 1939	St. Louis Bridge Signaling
Ry. Sig.	Mar. 1939	San Francisco Oakland Bay Bridge Signaling & Interlocking
Sig. Jou.	Mar. 1939	Signaling on San Francisco-Oakland Bay Bridge
Ry Sig.	Apr. 1939	San Francisco Oakland Bay Bridge Interlocking Plants
Ry. Sig.	May 1939	Cab Signaling and Train Control on S.F.-O.B.B.
Ry. Age	May 13, 1939	Signaling for a Train a Minute on S.F.-O.B.B.
Ry. Sig.	July 1940	Two New Interlockings Replace Old Plants at Atlanta Term.
Ry. Sig.	Nov. 1940	New Interlockings at Windsor, Ontario on M.C.
Ry. Sig.	Feb. 1941	L. & N. Installs Retarders in De Coursey Yard
Ry. Sig.	Apr. 1941	Remote Control Installation (Soo)
Ry. Sig.	May 1941	Modern NX Interlocking Replaces Mech. Plant (IHB)
Ry. Sig.	July 1941	Automatic Signaling and Tunnel Protection (D. & S.L.)
Sig. Jou.	July 1941	Moffat Tunnel Signaling
Sig. Jou.	Aug. 1941	A.P.B. Signaling on the Moffat Road
Ry. Sig.	Sept. 1941	C.T.C. Installed on Delaware & Hudson
Ry. Sig.	Oct. 1941	C.T.C. on the D. & R.G.W.
Sig. Jou.	Feb. 1942	New NX Interlocking Installed by N.Y.C. (Dunkirk)
Ry. Sig.	Apr. 1942	Modern Plant Installed by L. & N. (Latonia)
Ry. Sig.	Aug. 1942	B. & M. Replaces Semaphores with Light Signals (SC)
Ry. Sig.	Oct. 1942	Double-Track Automatic Signaling on the L. & N.
Ry. Sig.	Dec. 1942	cTc Solves War Traffic Problem on the T. & P.
Ry. Sig.	Feb. 1943	Centralized Traffic Control Installed on the Virginian
Ry. Sig.	Mar. 1943	All-Relay Interlocking Replaces Mechanical Plant (P. & P.U.)
Ry. Sig.	Apr. 1943	C.T.C. Installed on 39 Miles of the Burlington
Ry. Sig.	May 1943	Modernization of Automatic Signaling on N.Y.C.
Sig. Jou.	July 1943	NX Interlocking on New York Central
Ry. Sig.	June 1943	Modernization of Signaling on the T.H. & B.
Ry. Sig.	July 1943	C.N. Installs a Large All-Relay Electric Interlocking
Ry. Sig.	Aug. 1943	C.T.C. on 107 Miles of Single Track on the Rio Grande
Ry. Sig.	Sept. 1943	Grade Separation and Interlocking at Herkimer on N.Y.C.

Ry. Sig.	Oct. 1943	L. & N. Installs C.T.C. on 26 Miles of Single Track
Sig. Jou.	Nov. 1943	N.Y.C. Installs NX Interlocking
Ry. Sig.	Dec. 1943	All-Relay Interlocking Installed At Birmingham (NX)
Ry. Sig.	Feb. 1944	C.P. Installs C.T.C.
Ry. Sig.	Mar. 1944	L. & N. Installs C.T.C. On an Engine District
Ry. Sig.	Apr. 1944	M.P. Operates by Signal Indication on 323 Mile Arkansas Div.
Ry. Age	Apr. 1, 1944	M.P. Operates 323-Mile Division by Signal Indication
Ry. Sig.	May 1944	N.Y.C. Installs Coded Track Circuits
Can. Trans.	June 1944	Centralized Traffic Control C.N.R. Atlantic Region
Sig. Jou.	Aug. 1944	Arkansas Division Mo. Pac. Has 236 Miles of C.T.C.
Ry. Age	Aug. 19, 1944	C.N. Installs C.T.C. on 185 Miles of Line
Ry. Sig.	Sept. 1944	C.T.C. on 185 Miles on Canadian National
Ry. Sig.	Nov. 1944	Rio Grande Has Longest C.T.C.
Ry. Sig.	Dec. 1944	Remote Control Project Saves Time on the B. & O.
Ry. Age	Jan. 6, 1945	G-R-S Personnel Changes
Ry. Sig.	Jan. 1945	M.P. Installs Automatic Blocks on 99 Miles of Single Track
Ry. Sig.	Mar. 1945	K.C.S. Installs C.T.C. on 46 Miles of Single Track
Ry. Sig.	May 1945	B. & M. Installs All-Relay Interlocking at Concord, N.H.
Ry. Sig.	June 1945	C.T.C. Solves Operating Problems on the Pere Marquette
Ry. Sig.	July 1945	I.C.C. Annual Signaling Statistics
Ry. Sig.	July 1945	C.T.C. On a Complete Subdivision (C.B. & Q.)
Ry. Sig.	Aug. 1945	Automatic Block Signals Installed on the Kansas City Southern
Ry. Sig.	Sept. 1945	All-Relay Elec. Interlocking on the Portland Terminal
Ry. Sig.	Oct. 1945	Interlocking at Bridge 66 Near Sandusky, Ohio
Ry. Sig.	Dec. 1945	M.P. Installs 153 Miles of Automatic Block Signaling
Ry. Sig.	Feb. 1946	Drawbridge Interlocking on the New York Central
Ry. Sig.	Mar. 1946	C.T.C. on 128 Miles of Denver and Salt Lake
Ry. Sig.	June 1946	Virginian Installs Five Interlockings Near Norfolk, Va.
Ry. Sig.	July 1946	All-Relay Interlocking on Southern Railway (Orange, Va.)
Ry. Sig.	Aug. 1946	C.T.C. on Complete Subdivision on C.B. & Q.
Ry. Sig.	Aug. 1946	I.C.C. Annual Signaling Statistics
Ry. Sig.	Oct. 1946	New Interlocking on the P.M.
Ry. Sig.	Dec. 1946	Pere Marquette Installs cTc

Jack Shapley Fights Bronchial Pneumonia

Returning from a New York trip on Friday, February 14, Jack did not feel well. Thinking it was a cold, he took to bed to throw it off. On Saturday his doctor diagnosed his trouble as bronchial pneumonia. We are pleased to report that Jack is slowly recuperating with the help of sulpha drugs and the expert care of Mrs. Shapley.

* * *

W. K. Howe Improving

After a heart attack suffered while driving in his car on East Avenue, Winthrop Howe, retired vice president and chief engineer, is reported to be coming along nicely. Mr. Howe has left the hospital and is back at his home on Oxford Street.

* * *

Committee of Direction to Meet in Rochester

Meeting in Rochester March 11 and 12 for their quarterly deliberations, the Committee of Direction of the A.A.R. Signal Section will be guests of G-R-S. Headquarters will be the Sheraton Hotel.

* * *

Gardenville (WNYH) Train Communication in Service

Space radio communication on 160.41 megacycles was placed in service February 19 at the Gardenville classification yards (about 10 miles SW of Buffalo, N.Y.) on the New York Central. The installation consists of four locomotive equipments and 1 wayside, with a special check system to inform the engineman that the radio is working properly. The cab signal system will be retired. DeWitt, Selkirk and Gibson Yards are next for train communication.

Centralized Traffic Control by Space Radio

In operation at the present time between our West Avenue and Genesee plants is the prototype of a centralized traffic control system using space radio for the transmission of controls and indications between the control office and the field stations.

This description covers the principal characteristics of this new system as found in the prototype. It should be borne in mind that the method described is only one of several ways we can use to accomplish our aim, namely, to transmit controls and indications between remote points through space instead of over line wires. The purpose of this article is to direct your thinking along these lines and to stimulate your imagination in this new and relatively unexplored field. Please pull out the folded insert, page 23, for reference as you read on.

A. Elements of the System

The elements of the system which are already familiar to all of us are the control panel and relays (located at West Avenue) and the control and indication relays at the two ends of a typical passing siding (at Genesee) equipped with Model 5D dual controlled switch machines and the full complement of Type SA signals and circuits.

B. Transmission Means

To bridge the space between control office and field stations very-high-frequency radio waves are transmitted both ways. The outbound controls are "carried" on an 80-megacycle carrier and the inbound indications on a 77-megacycle carrier.

The various controls and indications in this set-up are differentiated by audio frequencies spaced 300 cycles apart, as listed in the two tabulations on the accompanying diagram. These audio frequencies or "tones" as they are called on the diagram, are created by

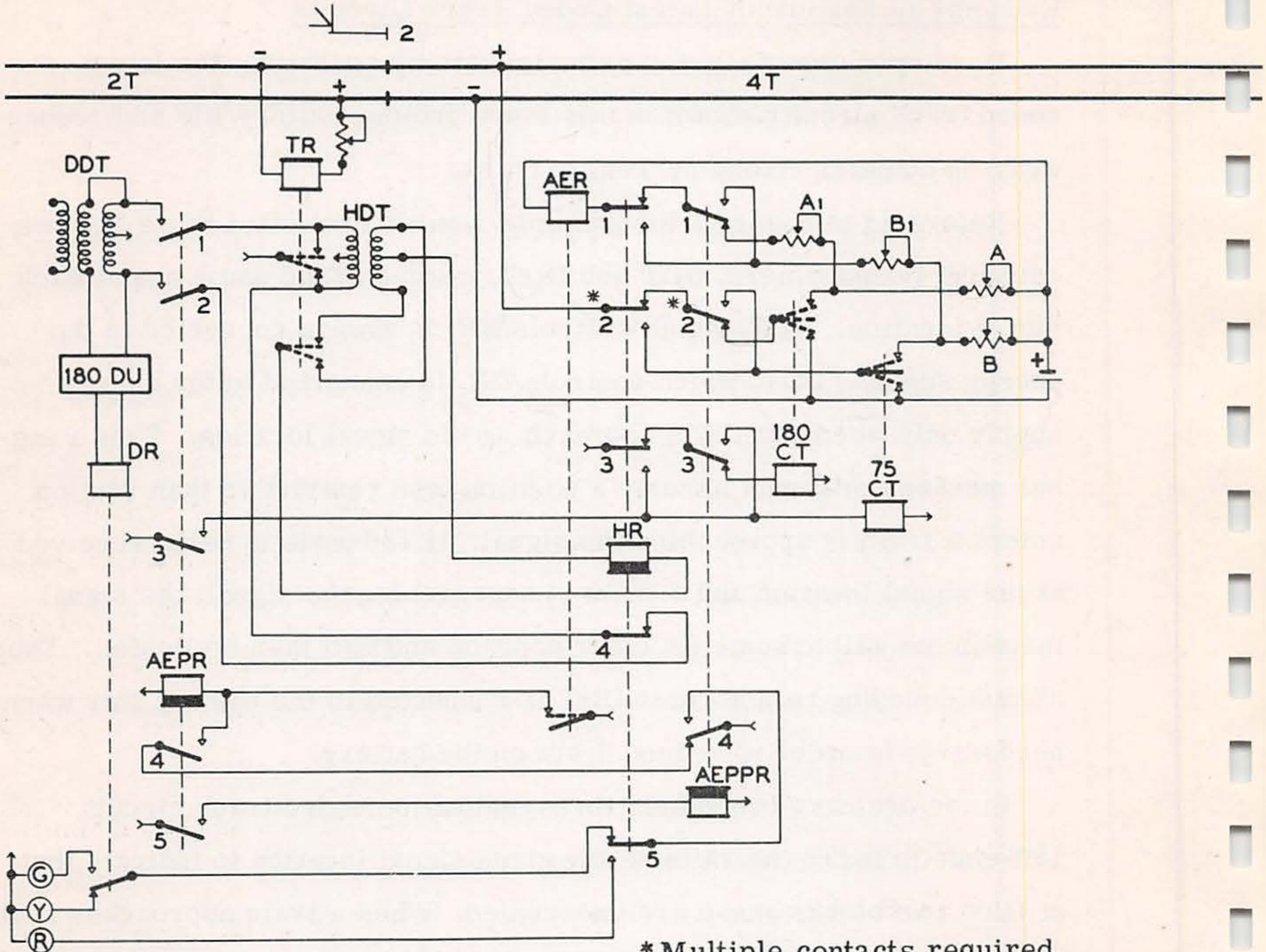
G-R-S NEWS
June 1947

Economy is Feature of Latest Coded Track Circuits

Developed especially for primary-battery operation, the latest coded track circuits shown in this issue prolong battery life and reduce wear on contacts coding current to track.

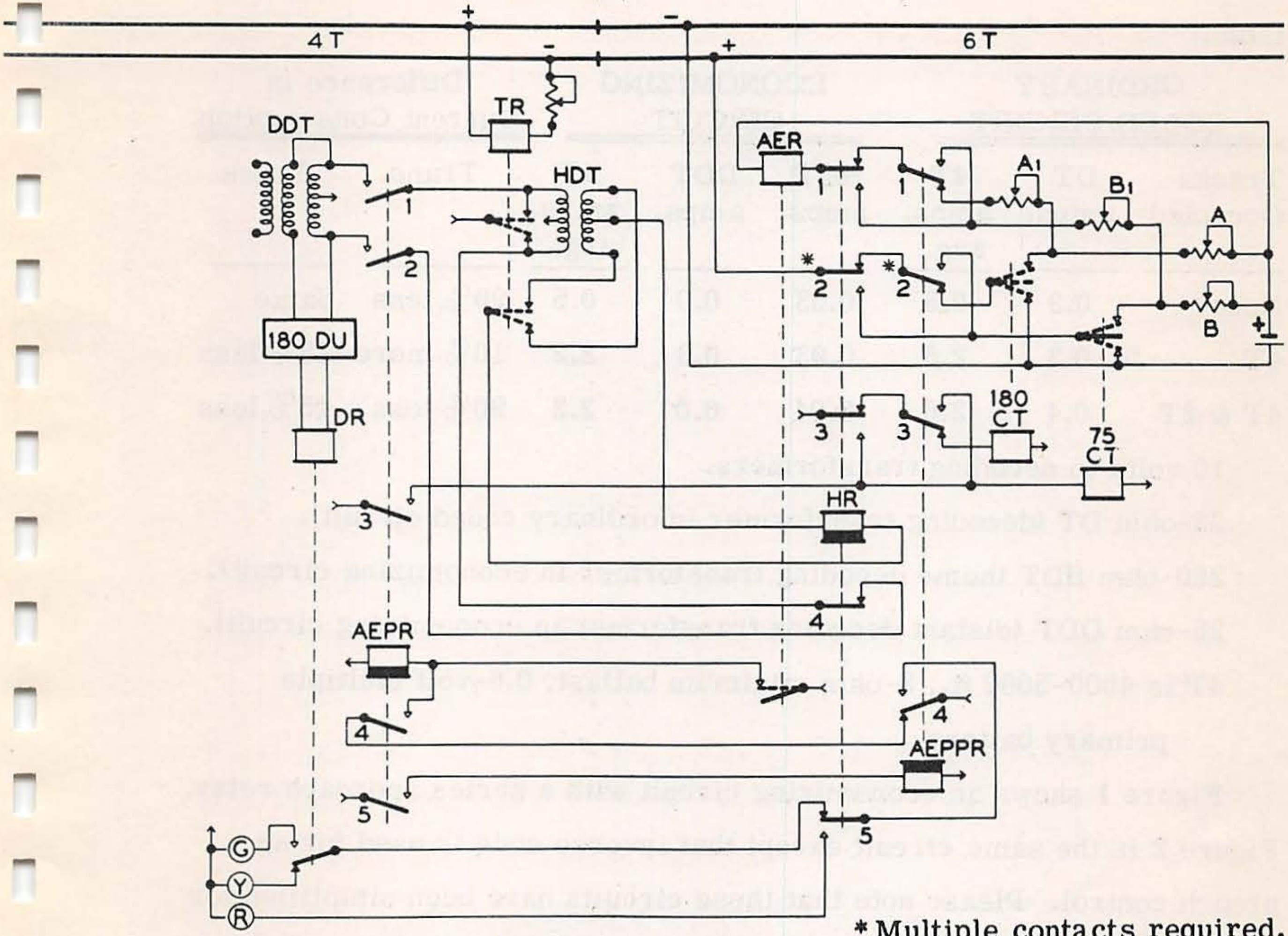
Referring to Figure 1 for example, you will note that there are two decoding transformers, HDT and DDT, instead of the usual one at each signal location. HDT, which controls HR, is always connected to the energy supply. DDT, which controls DR, is connected to the energy supply only when a train is approaching the signal location. Thus a signal mechanism cannot assume a position less restrictive than caution unless a train is approaching the signal. If 180-code is being received at the signal location and a train is approaching the signal, the signal mechanism will assume its clear position and will then be lighted. Thus distant decoding transformer DDT is connected to the battery only when necessary, in order to reduce drain on the battery.

In the ordinary two-block, three-indication coded track circuit, 180-code is fed to the rails at any given signal location to indicate that at least two blocks ahead are unoccupied. When a train approaches such a location, the 180-code is, of course, fed into a shunted track. When the track is shunted, the current being interrupted by the track-feeding contacts is at its maximum. Thus a reduction in code rate from 180 to 75 at this time is of material advantage in prolonging the life of the contacts coding current to the track, as at 75-code the contacts perform only 41 percent of the operations they would perform during a like period at 180-code. For this reason, means is provided in the economizing circuit to change the code rate to 75 whenever a train enters upon a track that is being fed 180-code.


2
2T
4T
TR
DDT
HDT
AER
A1
B1
A
B
180 DU
DR
180 CT
75 CT
HR
AEPR
AEPPR
G
Y
R
1
2
3
4
5

* Multiple contacts required.

Figure 1. Simplified coded track circuit for single-direction operation showing typical signal locations with series approach relay and economizing circuit for primary-battery operation.


4
4 T
6 T
+
-
TR
DDT
HDT
AER
A1
B1
A
B
1
2
180 DU
DR
3
HR
4
AEPR
5
G
Y
R
180 CT
75 CT
AEPPR

* Multiple contacts required.

The following table shows how the current consumption of an economizing circuit such as is shown in Figure 1, compares with that of an ordinary coded track circuit. Note that this table is based upon circuits without inverse code and with characteristics as noted below the table.

ORDINARY CODED CIRCUIT			ECONOMIZING CIRCUIT			Difference in Current Consumption	
Tracks Occupied	DT amps.	4T amps. avg.	HDT amps.	DDT amps.	4T amps. avg.	Trans.	Track
None	0.3	0.5	0.03	0.0	0.5	90% less	Same
4T	0.3	2.6	0.03	0.3	2.2	10% more	15% less
4T & 2T	0.4	2.6	0.04	0.0	2.2	90% less	15% less

10 volts to decoding transformers.

25-ohm **DT** (decoding transformer in ordinary coded circuit).

250-ohm HDT (home decoding transformer in economizing circuit).

25-ohm DDT (distant decoding transformer in economizing circuit).

4T is 4000-5000 ft., 3-ohm minimum ballast, 0.6-volt multiple primary battery.

Figure 1 shows an economizing circuit with a series approach relay. Figure 2 is the same circuit except that inverse code is used for approach control. Please note that these circuits have been simplified for purposes of clarity. Resistors, condensers, multiple contacts, etc., which are not essential to an understanding of the operating fundamentals, have been omitted.

Operation of the circuit shown in Figure 1 is as follows: with tracks 2T and 4T unoccupied, 180CT at signal 2 is energized through HR front contact number 3 and AEPPR back 3. Current from the positive side of the track battery flows along two parallel paths as far as the front contact of 180CT. One path is through resistor A. The other path is through AER, through HR front 1, AEPPR back 1, and resistor A_1. The current paths join at 180CT front, and current is coded to 4T through AEPPR back 2 and HR front 2 (note that contacts marked with an asterisk are multipled in actual practice).

The respective values of resistors A and A_1 are such that the major part of the current flows through resistor A. When 4T is unoccupied, the current through AER and resistor A_1 is just under the pickup value of AER. This condition is secured by proper adjustment of resistor A_1. But when 4T is shunted by an approaching train, the current to 4T through resistor A and through AER and resistor A_1 increases substantially (see accompanying table for typical values), and enough current flows through AER and resistor A_1 to cause AER to operate.

You will note that there are also two other resistors, B and B_1. Resistor A limits the major part of the current to track, and resistor A_1 limits the current through AER when 180-code is being fed to the rails. Resistor B limits the major part of the current to track, and resistor B_1 limits the current through AER when 75-code is being fed to the rails. Two sets of resistors are used because 180-code requires more current than 75-code, and so, to secure greatest possible battery economy, a higher resistance, B, is introduced into the circuit when 75-code is being fed to the rails.

However, proper functioning of AER depends upon the maintenance of a certain relationship between the current values in the two branches of the parallel circuit paths between the battery and the front contact of whichever code transmitter is controlling the current to the rails. Thus when resistor B is introduced into the circuit instead of resistor A, resistor B_1 must be used instead of resistor A_1 so that the same current relationship is maintained, i.e. $A: A_1 :: B: B_1$.

When a train approaches signal 2, AER pulses in response to the code being transmitted and supplies current through its front contact to AEPR, a slow-release relay. In order to provide positive pickup of AEPR when it has once closed its front contacts, a stick circuit is provided through AEPPR back 4 and AEPR front 4. When AEPR picks up, distant decoding transformer DDT is energized through AEPR fronts 1 and 2 and HR front 4. If TR is operating in response to 180-code, decoding unit 180DU will pass sufficient energy to pick up DR, thus selecting a green aspect for signal 2. 75CT is energized through AEPR front 3.

AEPPR, a slow-pickup relay, is energized through AEPR front 5 and closes its front contacts. AEPPR front 1 selects resistor B_1 to be in series with AER, and AEPPR front 2 selects 75-code to 4T. AEPPR front 3 also applies energy to 75CT in multiple with AEPR front 3. AEPPR front 4 lights the signal lamp as selected by HR and DR.

As soon as the train shunts 2T, TR ceases to operate and comes to rest with its back contact closed. HR is deenergized and cuts energy off DDT by opening HR front 4. Thus no battery current is wasted by keeping DDT energized any longer than is necessary.

When the train clears 4T, AER ceases to operate, dropping AEPR and AEPPR. 75CT remains energized through HR back 3 and continues to pass 75-code to 4T through HR back 2 until the train clears 2T and HR again picks up, at which time the contacts again assume the positions shown in Figure 1 if 4T remains unoccupied.

In this manner, two important battery- and contact-saving results are achieved: DDT is energized only when required, and 180-code is not fed into a shunted track except for the time it takes to pick up AER.

The operation of the circuit shown in Figure 2 is similar except that the approach relay, AR, is controlled by inverse code. The energization of DDT and the selection of 75-code to the track occur promptly upon entrance of a train on 4T. The variable reactor shown in series with TPB is used to adjust the duration of the inverse-code impulses. The half-wave rectifiers shown in series with TPA and TPB keep induced voltages of incorrect polarity from polarized relays TPA and TPB and from thus being unnecessarily dissipated in the windings of the relays. This results in more efficient utilization of the input to HDT.

In comparison with an ordinary coded circuit, the economizing circuit requires two additional devices, an extra decoding transformer and a repeater of the approach repeater (AEPPR). Note also in Figure 1, the series approach circuit, that AEPR must be a six-point relay. A four-point relay is used here in the ordinary coded circuit of this type.

* * *

Returns Reported on G-R-S Signaling Systems

The following information is taken from A.A.R. Chapter III. You may wish to include it in your "Signaling Statistics" volume.

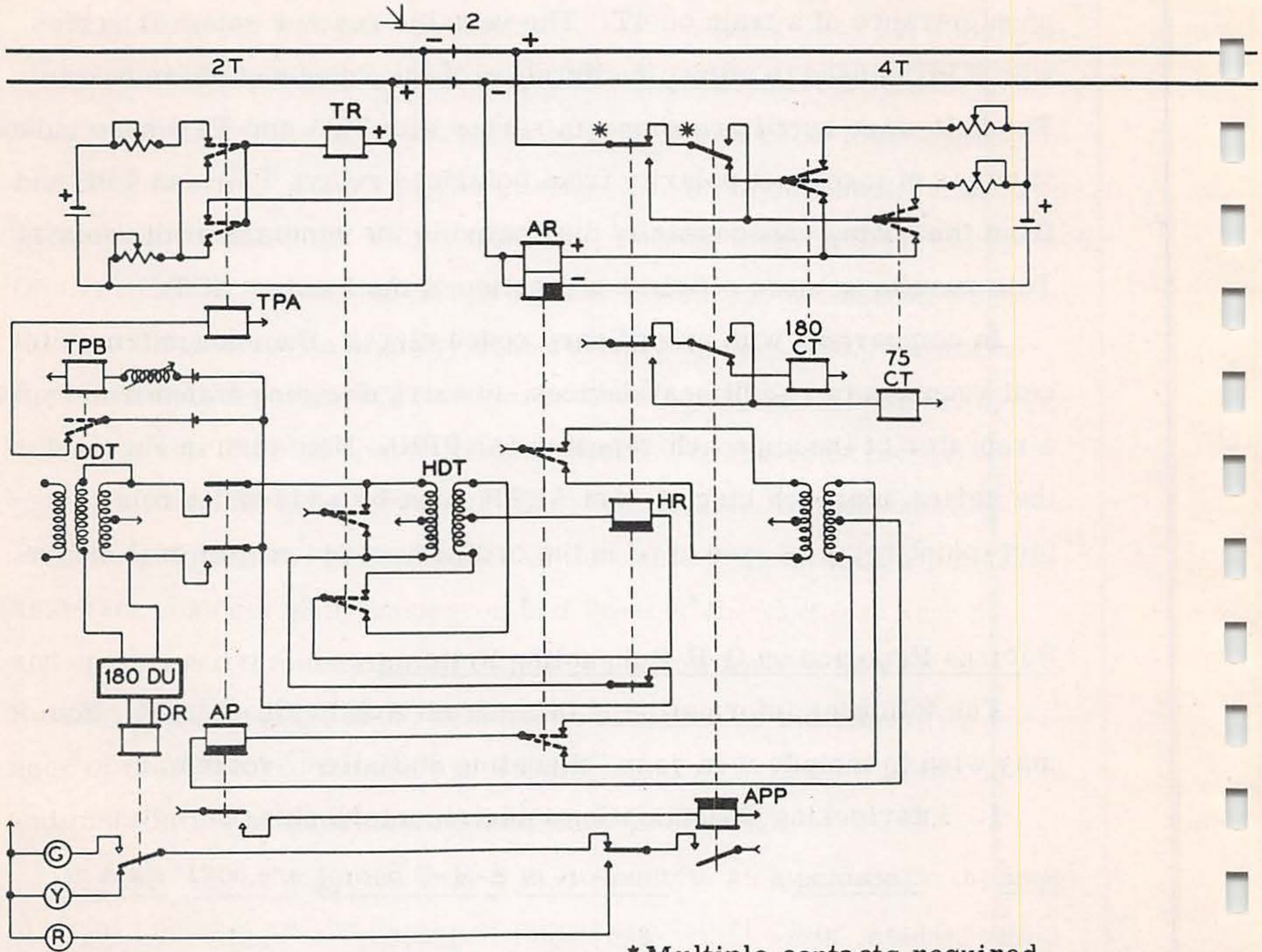
1. Interlocking Consolidation (electric interlocking).

Road	Location	Total Cost	Annual Saving	% Return	AAR Proceedings
CB&Q	Lincoln, Nebr.	$153,430	$24,667	16.0	Vol.XXIX Pg.7.
CB&Q	" "	20,525	4,363	21.2	Vol.XXIX Pg.8
C&NW	Nelson, Ill.	30,000	3,615	12.0	Vol.XXX Pg.10
"	Boone, Iowa	14,715	4,592	31.2	Vol.XXX Pg.12
"	Des Plaines, Ill.	31,000	4,240	13.7	Vol.XXX Pg.14

2. Centralized Traffic Control

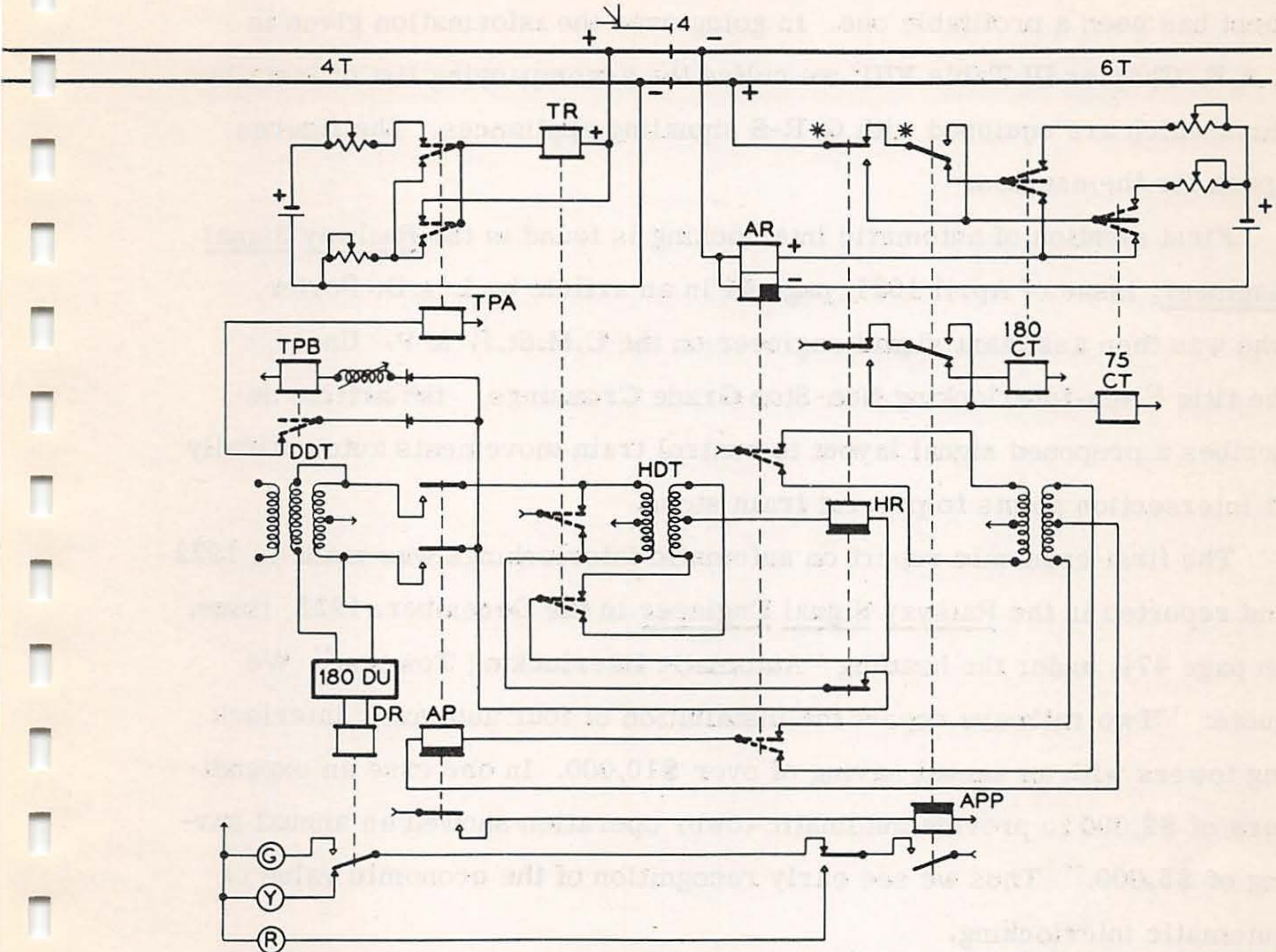
Road	Location	Total Cost	Annual Saving	% Return	AAR Proceedings
D&RGW	Grand Jc. to Helper	$1,391,880	$317,844	23.0	Vol.XLII Pg.21A
IC	Otto to Ashkum	21,561	10,178	47.2	Vol.XXX Pg.19
MP	Poplar Bluff to No. Little Rock	640,514	360,447	56.0	Vol.XLIII Pg.19

* * *


2
2T
4T
TR
AR
TPA
TPB
DDT
HDT
HR
180 CT
75 CT
180 DU
DR
AP
APP
G
Y
R

*Multiple contacts required.

Figure 2. Simplified coded track circuit for single direction running, showing typical signal locations with inverse code and economizing circuit for primary-battery operation.


4
4T
6T
TR
AR
TPA
TPB
180
CT
75
CT
DDT
HDT
HR
180 DU
DR
AP
APP
G
Y
R

* Multiple contacts required.

Automatic Interlockings are a Profitable Investment

From A.A.R. Signal Section reports it is evident that in nearly all cases where railroads have installed automatic interlockings, the investment has been a profitable one. In going over the information given in A.A.R. Chapter III Table VIII, we culled the accompanying list of installations which are equipped with G-R-S signaling appliances. The figures speak for themselves.

First mention of automatic interlocking is found in the Railway Signal Engineer, issue of April 1921, page 44 in an article by Les B. Porter, who was then assistant signal engineer on the C.M.St.P. & P. Under the title "Non-Interlocking Non-Stop Grade Crossings," the article describes a proposed signal layout to control train movements automatically at intersection points to prevent train stops.

The first economic report on automatic interlockings was made in 1922 and reported in the Railway Signal Engineer in the December, 1922, issue, on page 474, under the heading "Automatic Interlocking Towers." We quote: "Two railways report the installation of four automatic interlocking towers with an annual saving of over $10,000. In one case an expenditure of $2,000 to provide automatic tower operation showed an annual saving of $5,000." Thus we see early recognition of the economic value of automatic interlocking.

At the end of 1944 the I.C.C. reported 6,399 crossings of railway with railway. These are classified as having the following kinds of protection:

Interlocking	1,895
Automatic signals (automatic interlocking)	421
Derails on one line only, no protection on other	52
Hand-operated signals (without interlocking)	443
Gates	703
Total specially protected	3,514
Total not specially protected	2,885
Grand total	6,399

At the end of 1946 the total number of automatic interlockings using G-R-S equipment was 109.

* * *

Automatic Interlockings using G-R-S Appliances

Road	Location	In service	Type layout**	Trains per Day	Cost	Saving Per Yr.	%	Pub. Ref.†
B&O CT	Hammond, Ind.	1930	Gauntlet	20	2,800	5,551	198	34
BMT	Brooklyn, N. Y.	1934	Junction	496	15,000	4,261	28	174
CN/CP	Coniston, Ont., Can.	1936	S.T. Crossing	12	9,326	3,631	39	238
C&A	Streator, Ill.	1929	S.T. Crossing	22	10,487	3,000	29	36
C&A/CB&Q	4 interlockings in Ill.	1931 32	S.T. Crossing	14	24,500	21,000	86	176
*CB&Q	Forman, Ill.	1933	S.T. Crossing	20	4,523	1,619	36	177
GN	Wayzata, Minn.	1927	T.M.T. Jct.	25	11,118	5,000	45	45
GN	Barnesville, Minn.	1929	S.T. Jct.	16	5,800	2,310	40	46
GN	Pacific Jct., Mont.	1928	Junction	18	3,700	5,400	146	179
GN	Lohman, Mont.	1928	End T.M.T.	18	1,280	2,888	226	180
GN	Atwater & Pennock, Mont.	1933	Ends T.M.T.	14	1,540	3,058	199	181
NP	Philbrook, Minn.	1933	End T.M.T.	13	4,000	3,600	90	182
T&NO	La Rosen, La.	1934	S.T. Crossing	19	2,139	3,610	169	249
T&P	Paris, Tex.	1933	S.T. Crossing	12				250
T&P	Texarkana, Ark.	1936	S.T. Crossing	40				251
	Total of 13 of the above 15 installations				96,213	64,928		
	Average saving						67.5%	

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*Federal Equipment

†For publication references see AAR Chap. III p. 88

**Abbreviations: S.T. = Single Track
T.M.T. = Two Main Tracks

Data taken from A.A.R. Chapter III Table VIII

Walter Plogsted Becomes Vice President of Export

Walter John Plogsted, assistant to our president, has been made vice president in charge of export.

Mr. Plogsted was born in Buffalo, N. Y. on September 21, 1880, and attended grade and high school there. He graduated from Rensselaer Polytechnic Institute at Troy, N. Y. in 1903 with a bachelor's degree in civil engineering. Soon after he graduated from high school, he worked as clerk for the Lehigh Valley Coal Co., leaving them in September, 1899, to enter R.P.I. In the summer of 1901 he took a job as instrument man for New York State on highway construction. In July, 1903, he worked for the signal department of the Santa Fe, starting in as laborer, then helper, electrician on construction, maintainer, and construction foreman. In July, 1904, he joined the signal department of the Southern Pacific as foreman. In September of the same year he took a job as assistant engineer with Sanderson and Porter, contractors, New York, and engineered the installation of power conduit for the New Orleans Railways Co. In May, 1905, he became assistant to the consulting engineer of the Chicago, Indiana and Southern and was engaged in the design and installation of interlockings and water stations.

In May, 1906, he joined G-R-S in Rochester, as assistant to the commercial engineer on the design of signal and interlocking installations. In May, 1908, he became G-R-S resident engineer and superintendent of construction in New York, handling estimates, design and construction of automatic signaling and interlocking for railways in the Eastern territory, and was resident engineer on signaling for the New York Central Electric Zone and terminal. In January, 1913, he was placed in charge of sales, design and construction of signaling for G-R-S, residing in Australia and New Zealand. He returned to the U. S. in December, 1921, as export manager for G-R-S in Rochester. In April, 1926, he left for

England to take over as managing director of General Railway Signal Company, Ltd. and as our foreign representative in London. In March, 1930, he formed Railbrakes Ltd. of London and became its managing director in addition to his other duties. In November, 1939, he returned to Rochester, and was appointed assistant to the president in 1940. He remained in this position until his recent appointment to vice president in charge of export.

Mr Plogsted is a member of the Signal Section, A.A.R., life member of the American Society of Civil Engineers, a member of the Pan American Society, the Pilgrims (London), the Royal Automobile Club of England, and the Metropolitan Club, Washington.

* * *

Gene Auth Joins Chicago

Eugene Frank Auth has joined our company in the capacity of sales engineer, reporting to the Chicago office.

Mr. Auth was born on November 4, 1907 at Clarksdale, Ill. After finishing high school, he took an electrical engineering course at Milliken University in Decatur, Ill. He first entered railway service in June, 1923, with the Wabash as a laborer at Decatur, Ill., later as signal helper until October, 1927, at which time he entered the service of the Pennsylvania as a signalman on the St. Louis division. He worked for the Pennsylvania and the Burlington as a signalman, returning to the Pennsylvania in May, 1930. He served as signalman on various divisions of the Pennsylvania until July, 1934, and as special apprentice until September, 1936; assistant foreman telegraph and signals, New York division, until September, 1938; foreman electric traction, New York division, until January, 1939; and inspector telegraph and signals, New York division, until March, 1939. In March, 1939, he was appointed supervisor telegraph and signals, Long Island Railroad, at Jamaica, N. Y., and in July, 1940, was appointed supervisor telegraph and signals, Pennsylvania Railroad, Logansport division. In January, 1944, he was appointed assistant trainmaster, Grand Rapids division, serving in that position until December, 1944, when he entered the service of the Railroad Accessories Corporation out of New York. In October 1945 he was assigned their Western territory out of Chicago, which position he held until his recent change in employment.

* * *

Bob Phinney Made Engineer of Train Operation

Robert Morris Phinney, engineer associated with our commercial engineering department, has been made engineer of train operation with headquarters in Rochester, N. Y.

Mr. Phinney was born on December 7, 1882, in Barnstable, Mass. and attended the grade and high schools of that town. He graduated in 1904 from Massachusetts Institute of Technology with a degree of S. B. in electrical engineering.

In October, 1904, Mr. Phinney took a job as electrician with the Swan Electric Co. of Boston. His first contact with railroads began in October, 1906, as a draftsman on the electrification of the Fort Dodge, Des Moines and Southern. This work was contracted by the Northwestern Construction Co., Boone, Iowa, a subsidiary of the J. G. White Co. of New York, general contractors. In April, 1907, he joined the signal department of the Illinois Central as draftsman, transferring in August, 1908, to the Chicago and Northwestern in the same capacity. He advanced successively to chief draftsman, assistant engineer, and assistant signal engineer during this period until 1927, broken by an intermission of a year and a half spend during World War I as first lieutenant in the 415 Railway Telegraph Battalion, A. E. F.

In January, 1928, Mr. Phinney left the Northwestern to join our commercial engineering department, where he became associated with the early development and application of centralized traffic control. He specialized in the making of studies and estimates on contemplated railway signaling installations, particularly those involving centralized traffic control. These studies have been made for many U. S. and foreign railroads. In his new position Mr. Phinney will continue in the work of preparing traffic studies for the use of railroad operating officials.

* * *

GENERAL RAILWAY SIGNAL COMPANY

Highway Crossings in Non-Signaled Territory

Figure 1 shows a highway crossing circuit for use on non-signaled territory where alternating current is available. It is not a suitable circuit for use with automatic block signaling.

Track circuits 1T and 2T are fed alternating current, each from a separate winding of a Type U transformer. A Type B3VA half-wave track rectifier, Figure 2, is connected across the rails at the far end of each track circuit and changes the a.c. to half-wave d.c. to operate the d-c. interlocking relay. When a train enters either track circuit,

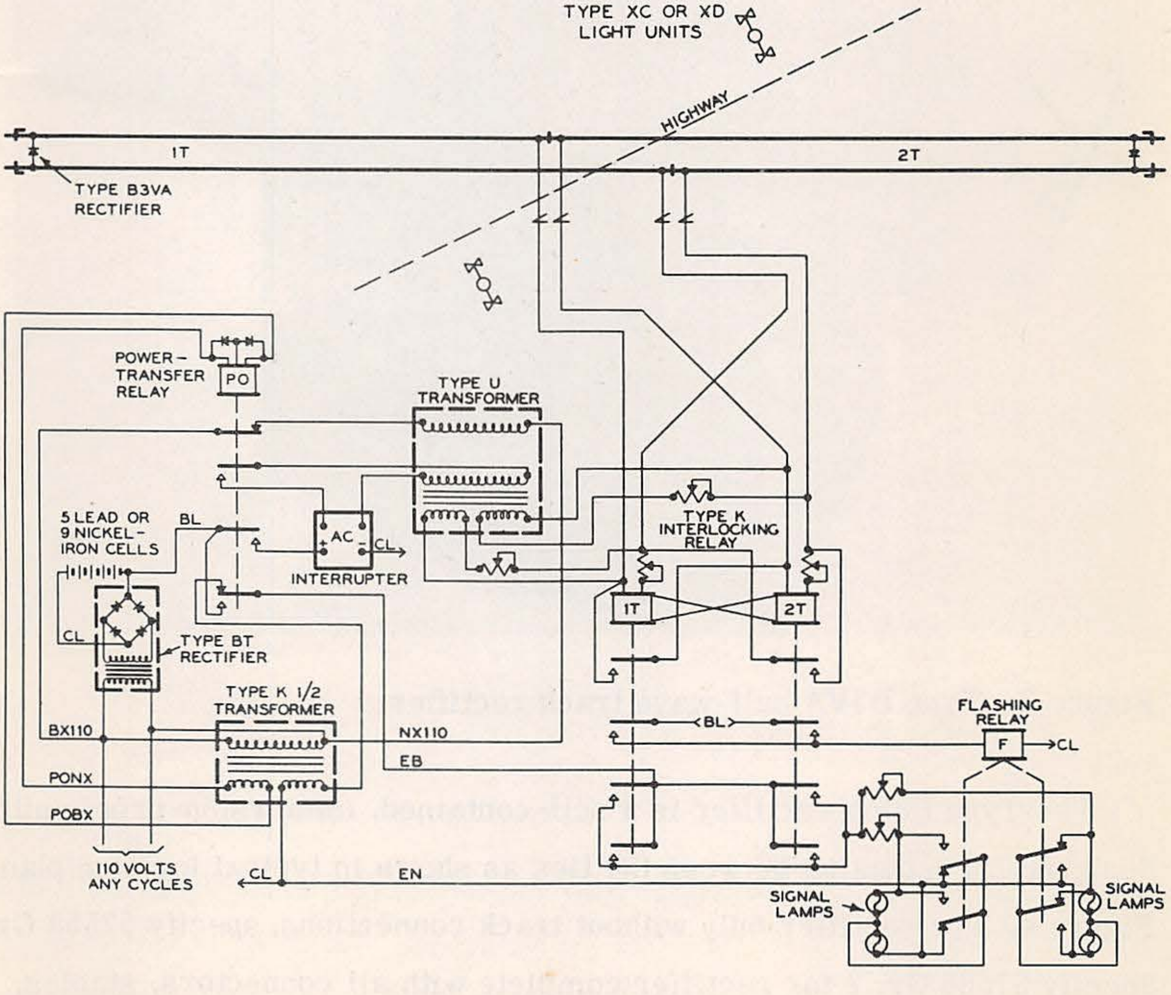

TYPE XC OR XD LIGHT UNITS
HIGHWAY
1T
2T
TYPE B3VA RECTIFIER
POWER-TRANSFER RELAY
PO
TYPE U TRANSFORMER
5 LEAD OR 9 NICKEL-IRON CELLS
BL
AC
CL
INTERRUPTER
TYPE K INTERLOCKING RELAY
1T
2T
CL
TYPE BT RECTIFIER
TYPE K 1/2 TRANSFORMER
BX110
NX110
EB
PONX
POBX
110 VOLTS ANY CYCLES
CL
EN
BL
FLASHING RELAY
F
CL
SIGNAL LAMPS
SIGNAL LAMPS

Figure 1. Highway crossing protection by flashing lights in non-signaled territory.

the rectifier is shunted out, and the coil of the d-c. interlocking relay associated with that track circuit releases its armature, as it is then in a parallel circuit with the low-resistance track shunt and the a-c. transformer output.

Power-off protection is provided by a Type B interrupter, Figure 3, which is energized and connected to a primary of the track transformer through back contacts of the power-transfer relay.

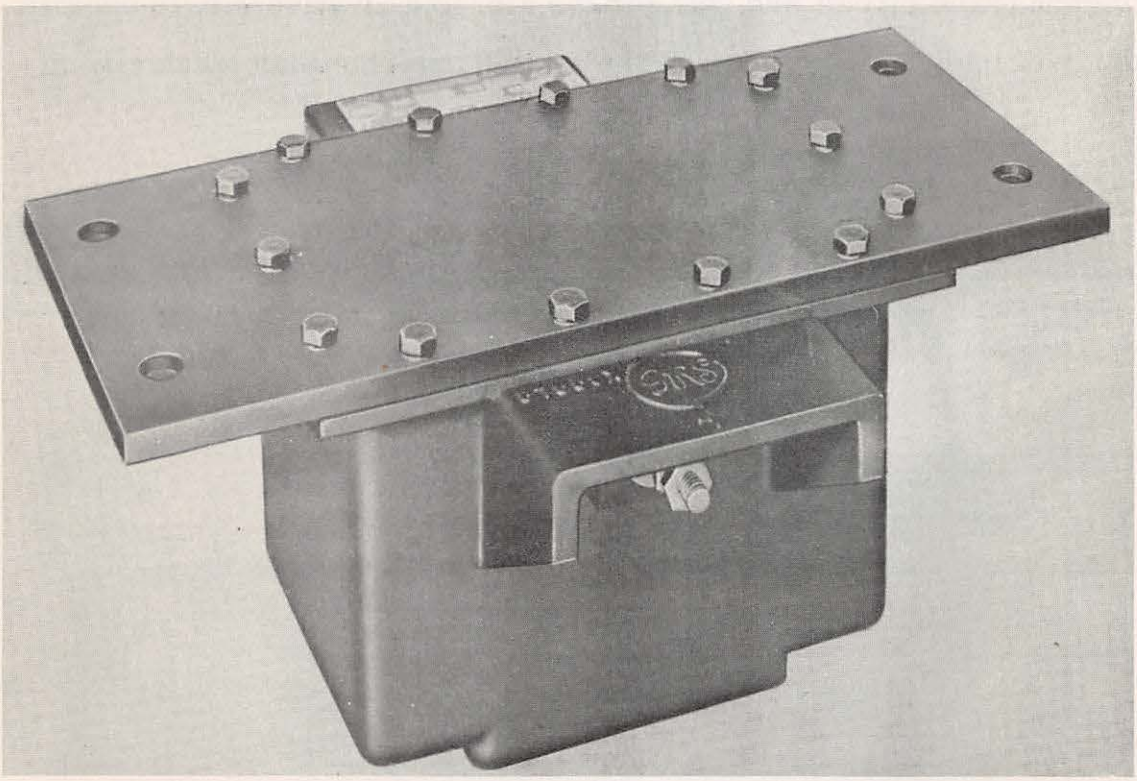


Figure 2. Type B3VA half-wave track rectifier.

The Type B3VA rectifier is a self-contained, immersion-proof unit designed for mounting between the ties as shown in typical location plan, Figure 4. For rectifier only without track connections, specify 57558 Gr. 1. Specify 57558 Gr. 2 for rectifier complete with all connectors, staples, lag screws, etc. for installation as shown in Figure 4.

This type of rectifier is not recommended for track circuits over 1500 feet long if ballast falls to 2.5 ohms per 1000 feet, or for track circuits over 2000 feet long if ballast falls to 4 ohms per 1000 feet. 2000 feet is the maximum recommended length even for the best ballast conditions.

Tag 55085-121, giving instructions for adjustment of track circuits, is shipped with each rectifier. Specification GES 1-66 shows typical wiring and tabulates a-c. and d-c. voltage and current readings for half-wave track circuits using the Type B3VA rectifier.

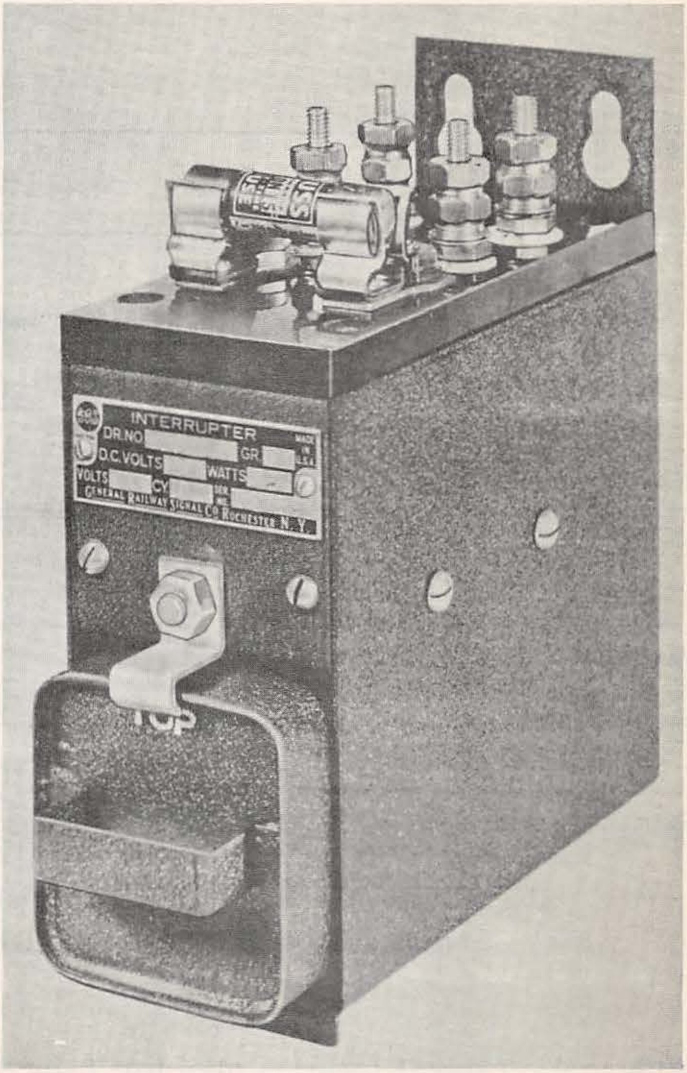

INTERRUPTER
DR.NO
GR
D.C.VOLTS
WATTS
VOLTS
CY
GENERAL RAILWAY SIGNAL CO. ROCHESTER N.Y.
TOP

Figure 3. Interrupter.

The Type B interrupter is a vibrator type, double-pole, double-throw pole changer, rated at 50 watts and 60 cycles. The vibrator unit is of the plug-in type and can be easily replaced. Instruction tag 55085-117 accompanies each unit. Ordering information is as follows:

Dwg. No.	D-c. Input	A-c. Output
57085 Gr. 1	10 volts	8 volts
57085 Gr. 2	12 volts	10 volts
57085 Gr. 3	24 volts	20 volts

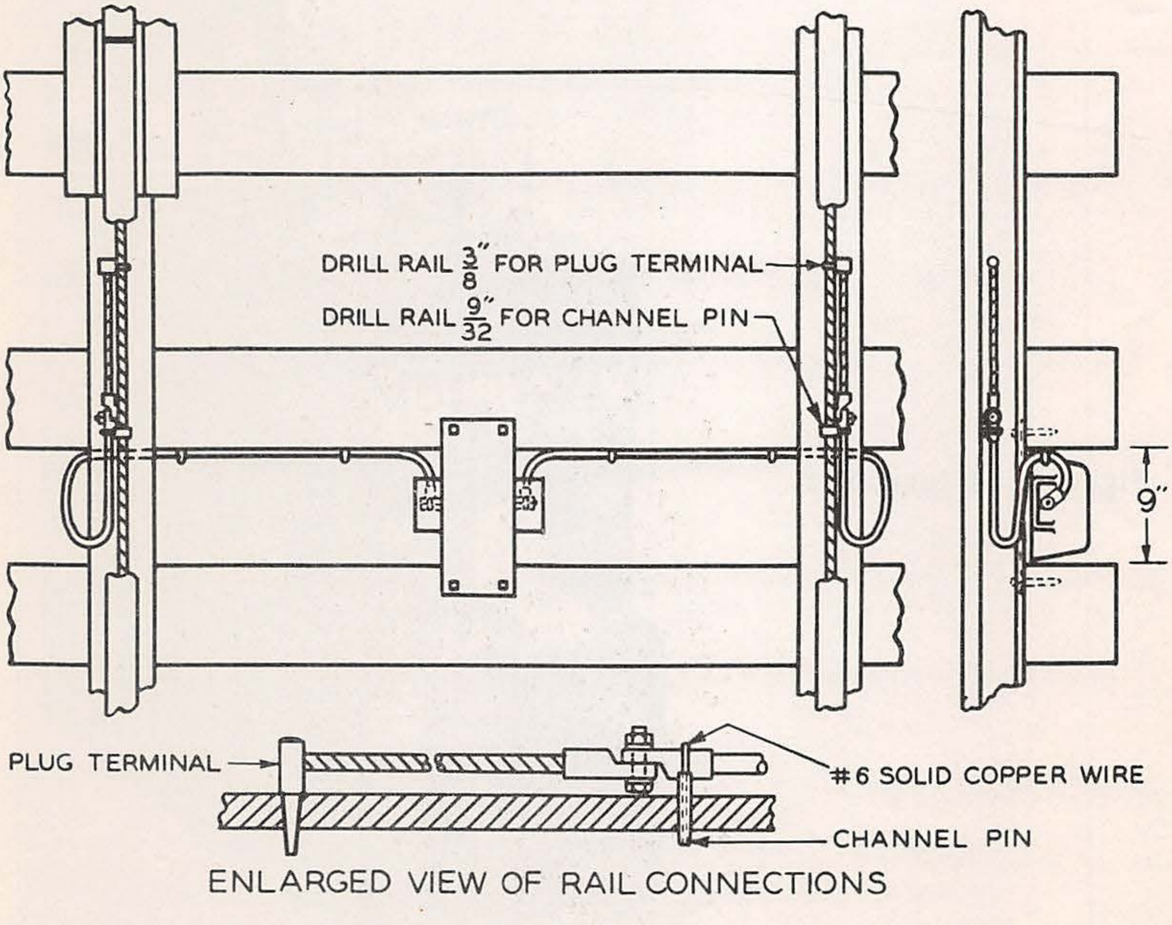

DRILL RAIL 3/8" FOR PLUG TERMINAL
DRILL RAIL 9/32" FOR CHANNEL PIN
9"
PLUG TERMINAL
#6 SOLID COPPER WIRE
CHANNEL PIN
ENLARGED VIEW OF RAIL CONNECTIONS

Figure 4. Typical location plan for Type B3VA rectifier.

The advantages of using this type of track circuit on highway crossing installations in non-signaled territory are:

1. No equipment other than the self-contained rectifiers are required at the farther ends of the track circuits.
2. All apparatus requiring any maintenance attention is centralized at one location.
3. This type of track circuit has a high shunting sensitivity, a characteristic which makes it well suited to locations where rail surfaces may be dirty or rusty.

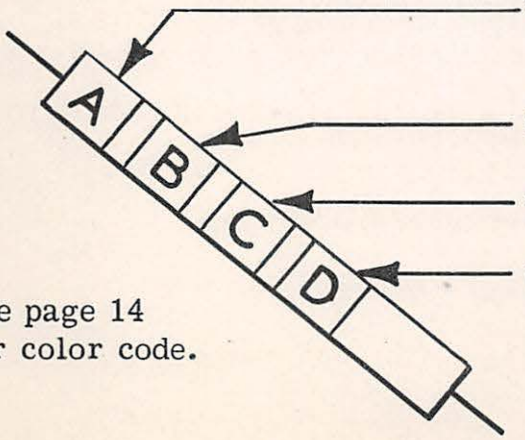
* * *

Resistor Color Code

Sid Freeman points out an error made in the April 1947 G-R-S NEWS which we should like to correct, at the same time passing on to you the resistor color code adopted by the Radio Manufacturers Association. This information may prove useful for reference.

On page 14 of the April 1947 NEWS the color code shown in Figure 15(a) is given as "brown-black-silver-red". This should be "brown-black-red-silver". The last two colors were inadvertently transposed. The resistance is 1000 ohms, tolerance ± 10 percent.

The resistors of the metallized or carbon types generally used in our apparatus have bands of color starting at one end as shown in the illustration below:



Color band A indicates first significant figure of resistance value in ohms.

Color band B indicates second significant figure.

Color band C indicates decimal multiplier.

Color band D, if shown, indicates tolerance in percent. If no color is shown, tolerance is ± 20 percent.

See page 14 for color code.

RESISTOR COLOR CODE

Color	Significant Figure	Decimal Multiplier	Tolerance (%)
Black	0	1	-
Brown	1	10	-
Red	2	100	-
Orange	3	1,000	-
Yellow	4	10,000	-
Green	5	100,000	-
Blue	6	1,000,000	-
Violet	7	10,000,000	-
Gray	8	100,000,000	-
White	9	1,000,000,000	-
Gold	-	0.1	5
Silver	-	0.01	10
No Color	-	-	20

* * *

GENERAL RAILWAY SIGNAL COMPANY

G-R-S NEWS

August 1947

Motor-operated Flasher Relay

A Type B Size 2 flasher relay operated by a constant speed d-c. motor has recently been commercialized. Designed for operation on 8, 10, and 12 volts, this relay operates to produce 39 to 42 flashes per minute and always stops with the same set of contacts closed when it is deenergized. The following description has been prepared to give you information in advance. Please send your emendations to the Advertising Department, so that we can publish an accurate and informative development sheet on the device.

*

I. GENERAL DESCRIPTION

The motor-operated flasher relay is built in the Type B plug-in design only. It is a Size 2 relay, 5 inches wide, 6-5/16 inches high and 8-3/8 inches deep. It plugs on to a standard Type B relay plugboard such as is illustrated in our Catalog Section E Part 31 Plate E3135. The relay and its plugboard are registered or matched by means of registration plates, such as are shown in our Catalog Section E Part 31 Plate E3171.

The relay is equipped with four sets of dependent contacts, platinum-silver to platinum-silver. The movable portion of the contacts (the heel) is driven by a spring toggle arrangement which is actuated through a gear train by a constant speed d-c. motor. A transparent plastic cover, gasketed with rubber, encloses the working parts.

II. RELAY ASSEMBLY

Figure 1 shows the relay assembly which consists of the motor, gear train, roller driven arm, spring toggle, and contacts - all supported on a single plate. This plate, in turn, is supported by two tubes which run from the front to the back of the relay. The tubes also serve as guides for the guide rods attached to the plugboard. Two special nuts screwed on the threaded end of the tubes hold the relay cover on. Flat follow-up springs under these nuts keep the cover tight against the relay base. Rubber gasketing is provided between the cover and the base. Figure 2 shows views of the relay with cover on and off.

The motor and its gear train are held on the plate by two 6-32 x 7/16 screws. Out of the gear train housing protrudes an eccentric drive shaft which carries a roller. This roller engages in the slot of a arm, Figure 3. There is a spring toggle linkage from the bottom of the arm to two fiber pushers which engage with the four heel contacts, one pusher to two heels. The contacts are made of platinum-silver, secured on long flat springs molded in plastic blocks, which are secured to the same plate which supports the motor. Wires soldered to the ends of the contact springs pass through two holes in the plate and terminate in soldered joints on terminal contacts which engage with the plugboard terminals when the relay is plugged in service. See "IV Internal Wiring" for connections.

The pushers strike stop-pins at the extremes of their travel.

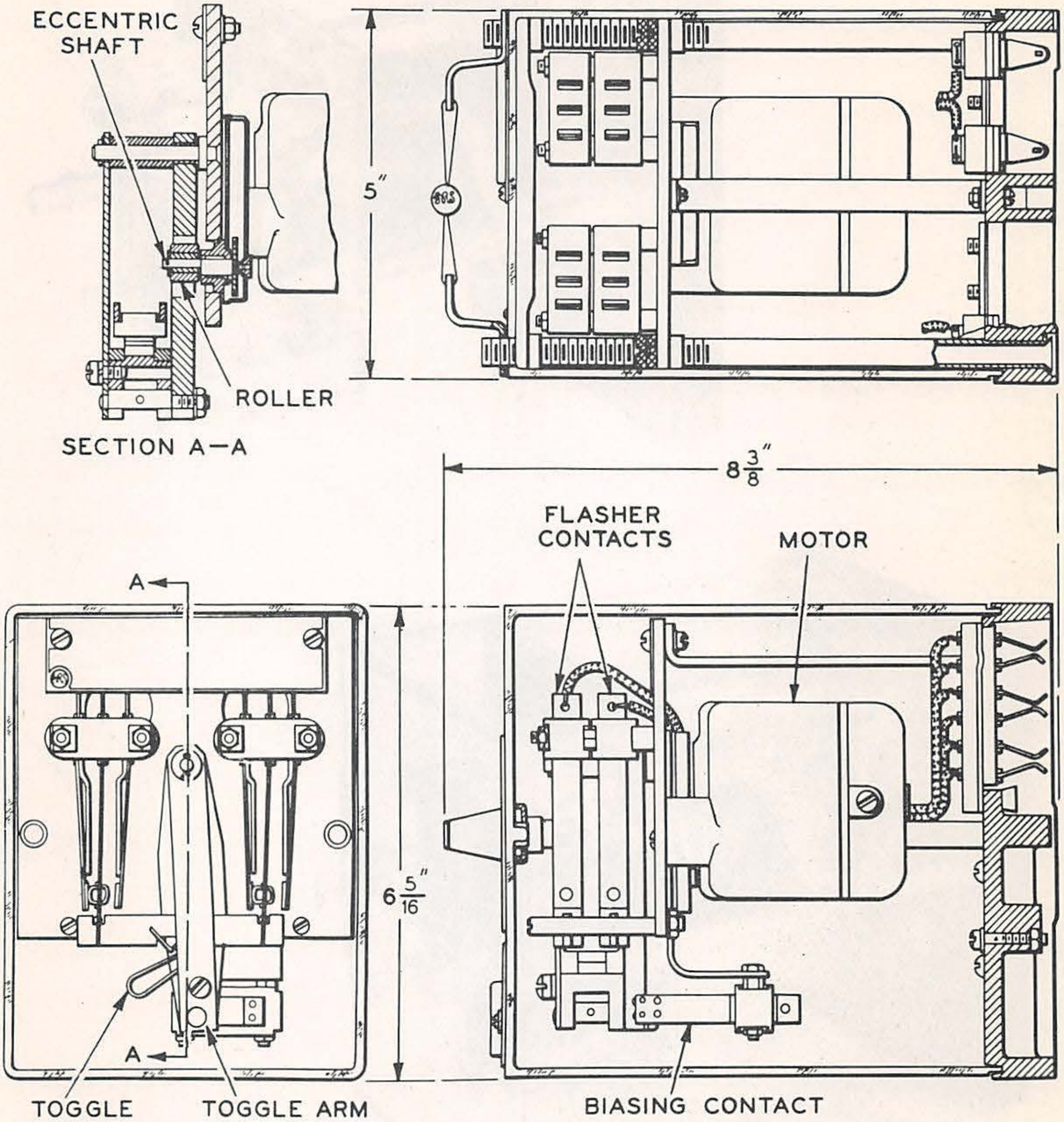

ECCENTRIC SHAFT
ROLLER
SECTION A—A
5"
8 3/8"
FLASHER CONTACTS
MOTOR
A
A
6 5/16"
TOGGLE
TOGGLE ARM
BIASING CONTACT

Figure 1. Details of Type B Size 2 flasher.

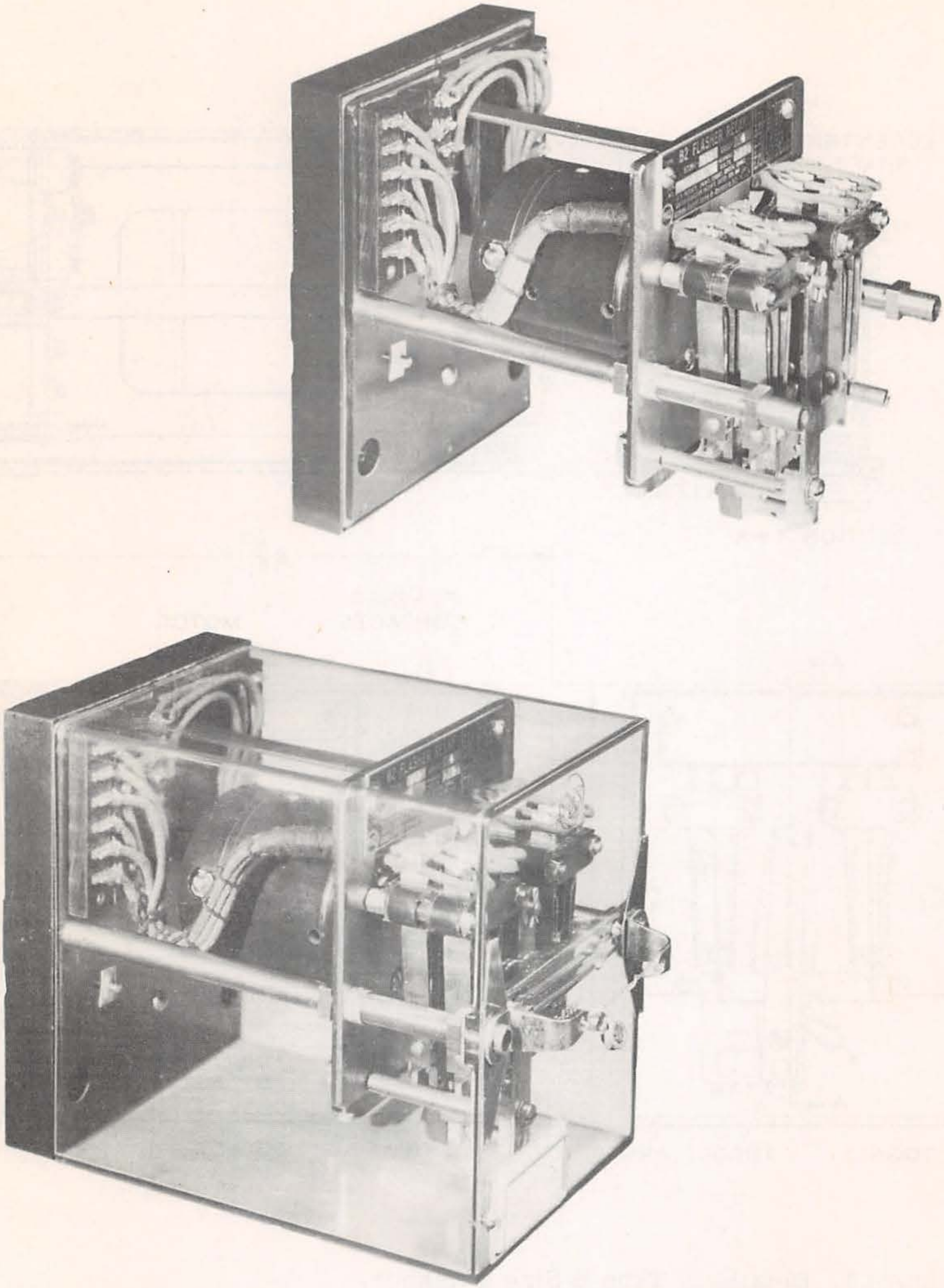

B2 FLASHER RELAY

Figure 2. Type B Size 2 motor-operated flasher.

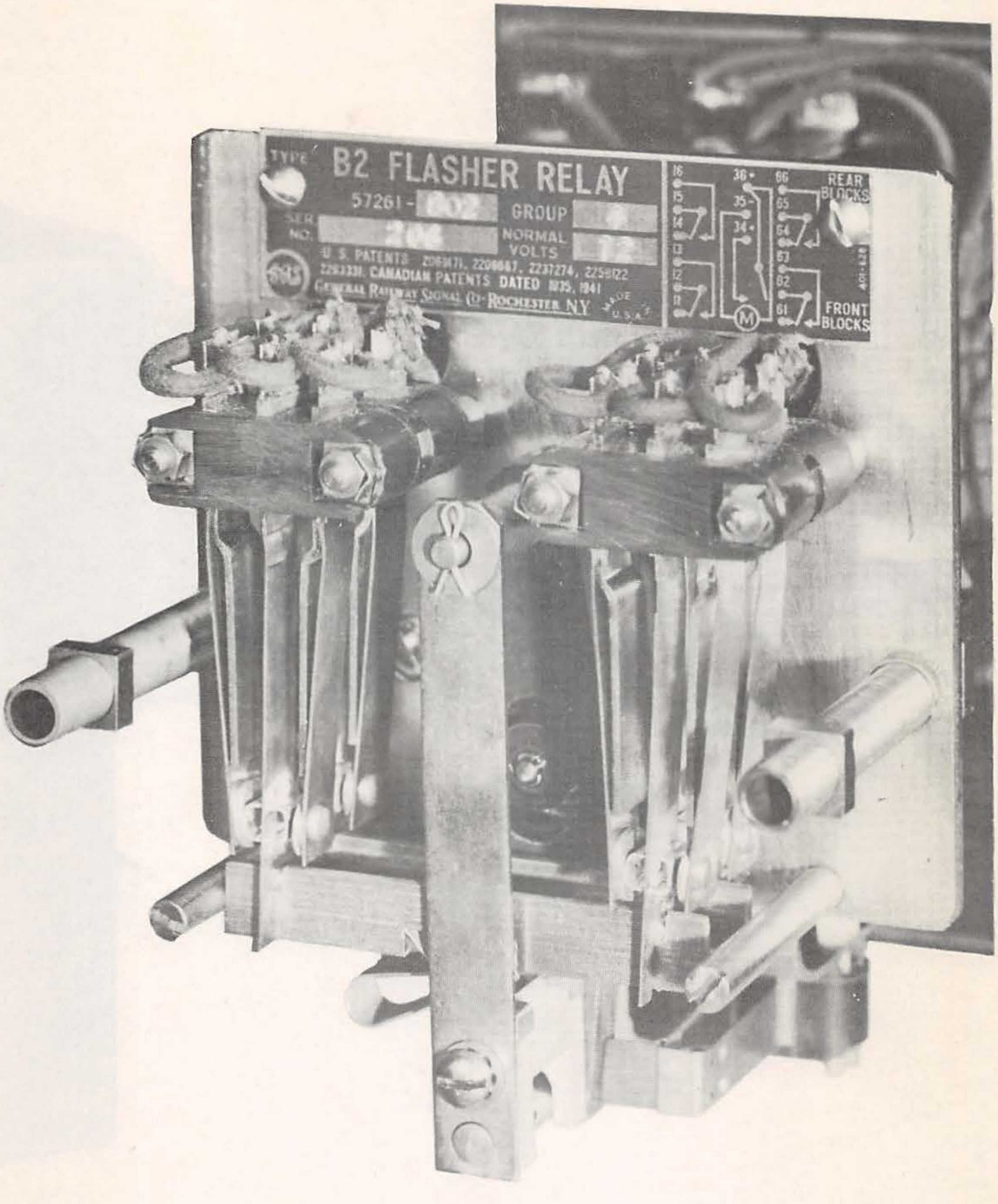

TYPE
B2 FLASHER RELAY
57261-002
GROUP
SER. NO.
204
NORMAL VOLTS
U.S. PATENTS
CANADIAN PATENTS DATED 1935, 1941
GENERAL RAILWAY SIGNAL CO. ROCHESTER N.Y.
MADE IN U.S.A.
REAR BLOCKS
FRONT BLOCKS
M

Figure 3. Close-up of toggle and contacts.

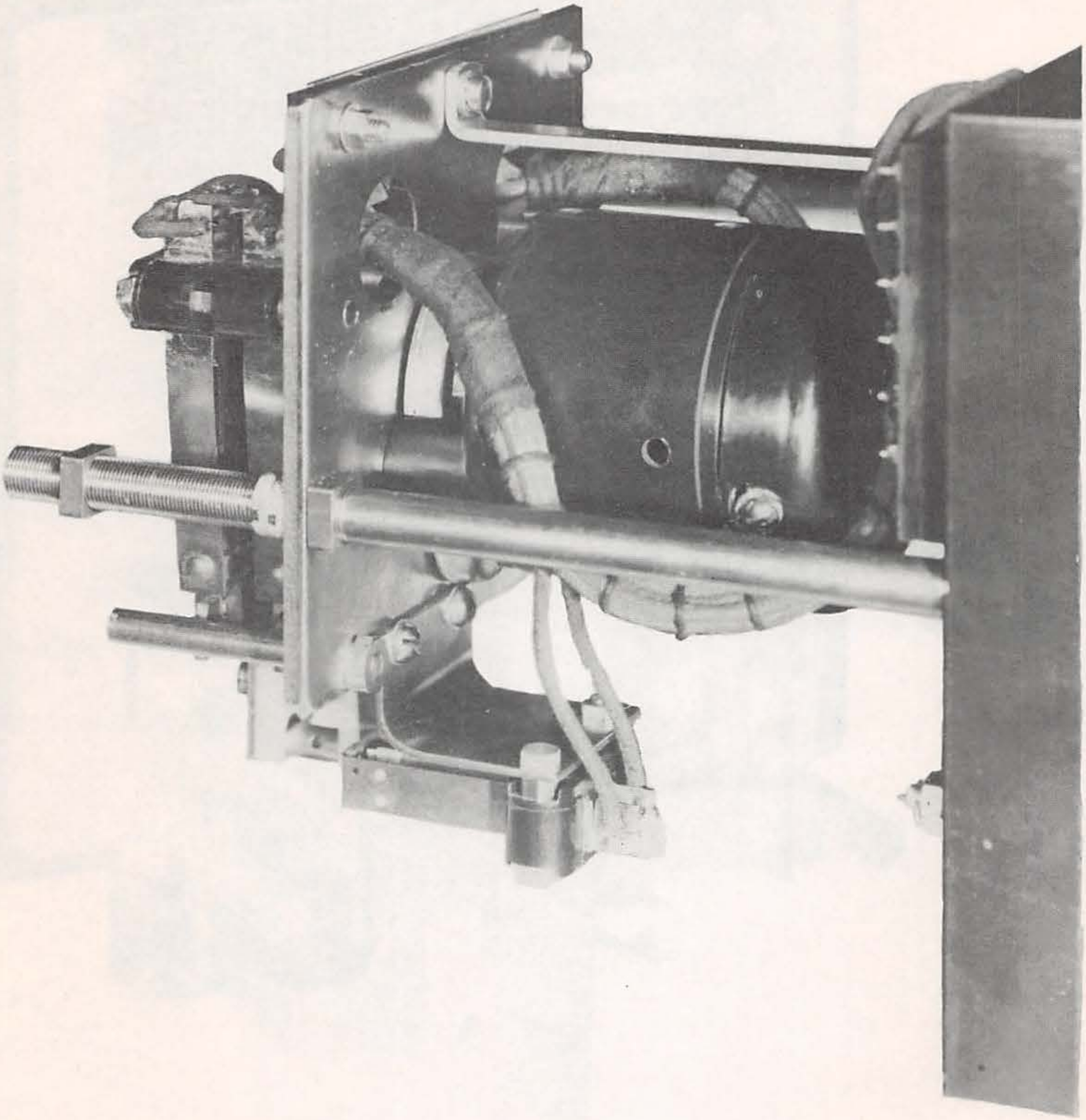


Figure 4. Biasing contact and motor.

In order to have the same contacts close when the relay is deenergized, a biasing (motor control) contact is mounted on the bottom of the plate aforementioned in such a position as to be opened when the toggle arm swings towards the contact. The motor circuit is thus always opened when the pushers are over to the left-hand stop pin, and the toggle arm has swung over to the right. See Figure 4.

In the base of the relay is a registration plate having a certain arrangement of holes, Figure 5. On the plugboard, which is mounted on the relay rack, there is also a registration plate having a certain arrangement of pins. When the relay is plugged on to the plugboard the pins and holes must match up before the contacts come into engagement to complete the circuits into the relay.

The purpose of the registration feature is to prevent plugging a relay in the wrong place. It takes care of important differences in relays such as in timing, contact arrangements, contact openings and operating voltages. In the case of the flasher relay, registry assures plugging into a circuit of a given voltage only that relay which has a motor designed for that certain voltage. Thus, on an 8-volt circuit only a relay with the 8-volt motor can be used.

III. OPERATION

A. General

From the description of the parts it is evident that the motor operates a simple spring toggle which causes the contact pushers to oscillate back and forth with about an 1/8-inch travel.

The speed of the output shaft of the gear train is 40 r.p.m. Hence the flashing rate is 40 per minute, nominally. The A.A.R. allowable variation is from 39 to 42 flashes per minute.

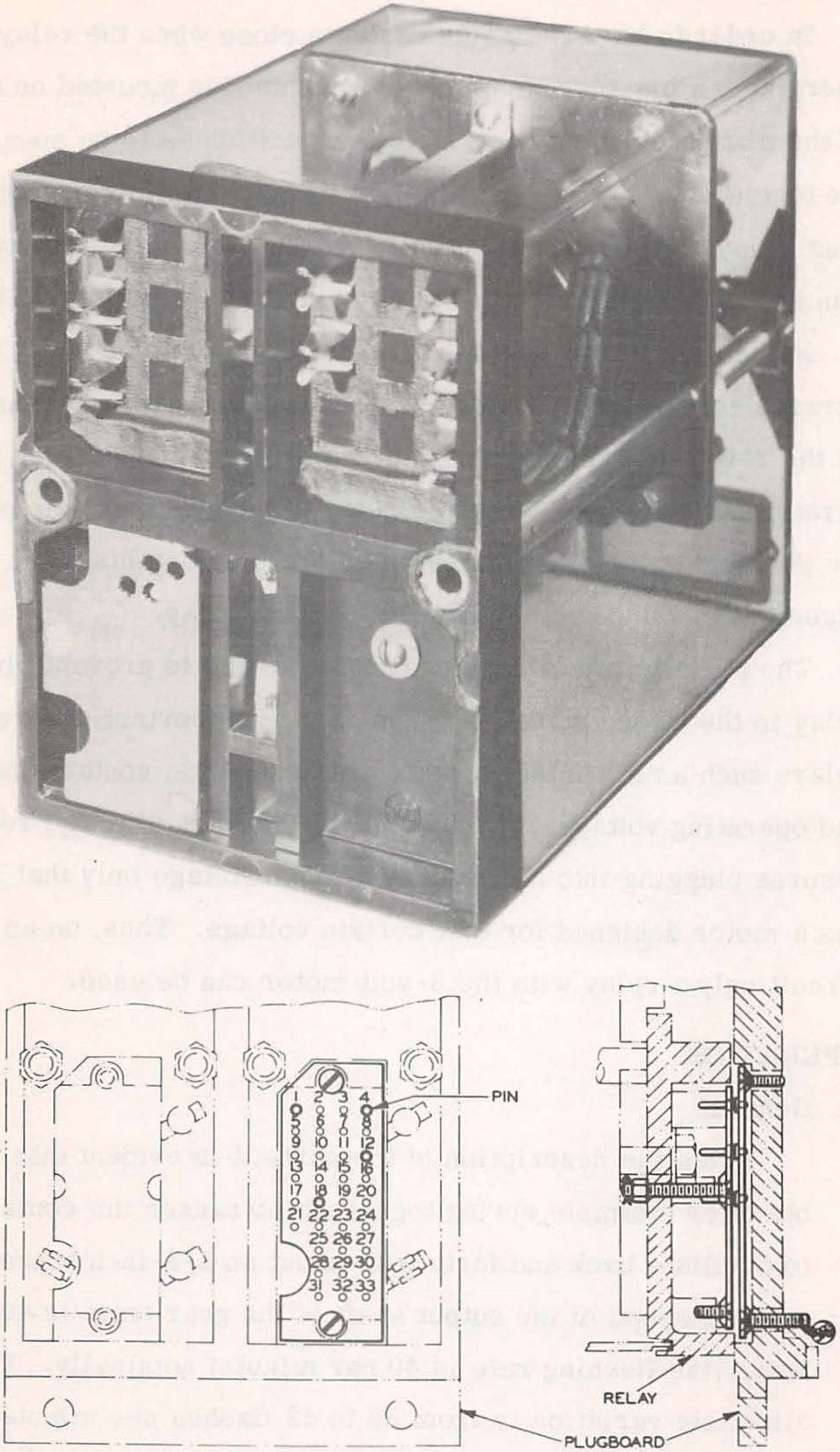

1 2 3 4
5 6 7 8
9 10 11 12
13 14 15 16
17 18 19 20
21 22 23 24
25 26 27
28 29 30
31 32 33
PIN
RELAY
PLUGBOARD

Figure 5. Registration plates on relay and plugboard.

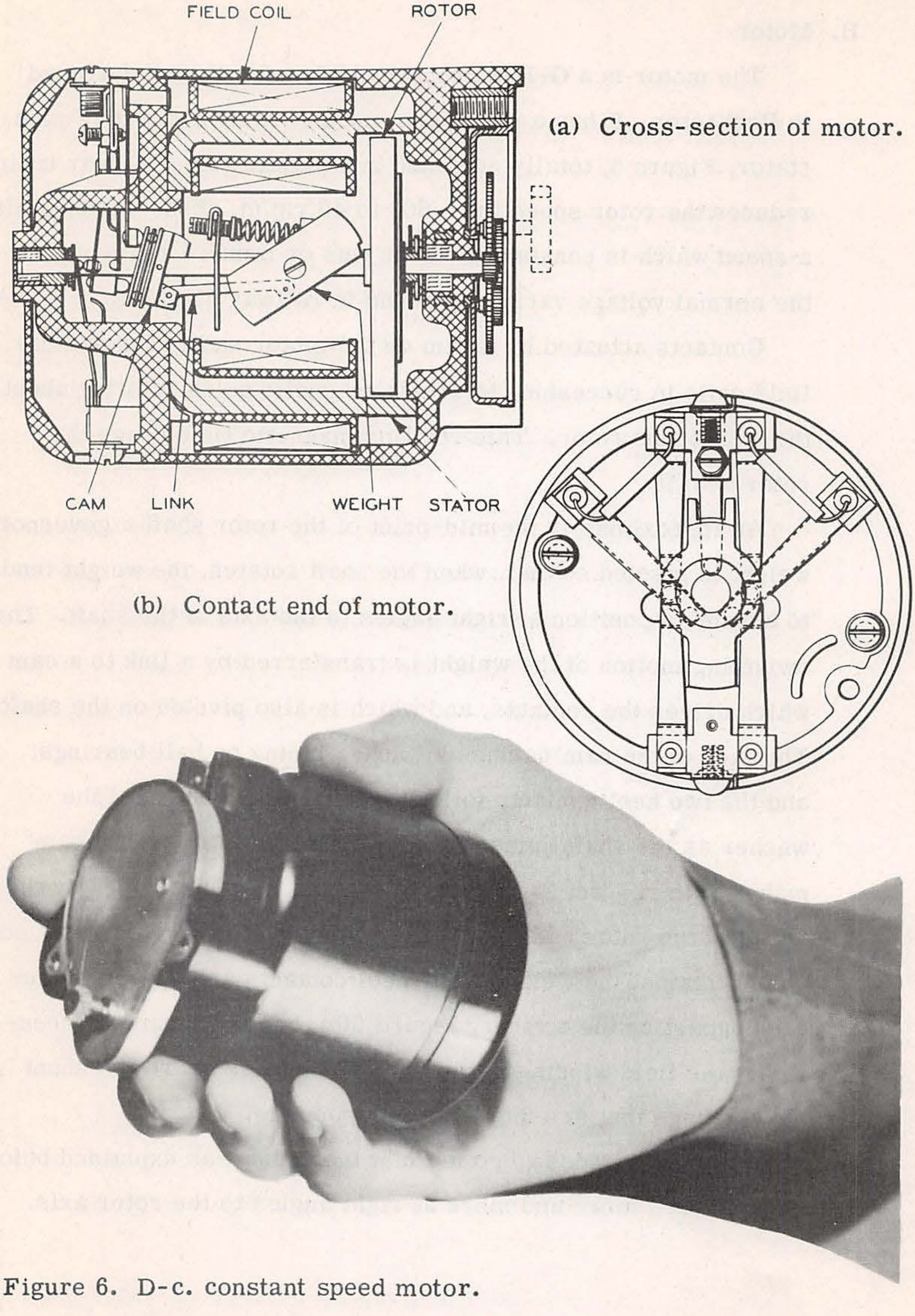
B. Motor

The motor is a G-R-S product, designed and manufactured in Rochester. It has a permanent magnet rotor and a four-pole stator, Figure 6, totally enclosed in a plastic case. A gear train reduces the rotor speed from 600 to 40 r.p.m. at the output shaft, a speed which is constant to about plus or minus 1 percent over the normal voltage variations found in railway signaling.

Contacts actuated by a cam on the motor shaft energize the field coils in succession to create magnetic poles rotating about the axis of the rotor. This rotating magnetic field drags the rotor with it.

At approximately the mid-point of the rotor shaft a governor weight is pivoted so that, when the shaft rotates, the weight tends to assume a position at right angles to the axis of the shaft. The swiveling motion of the weight is transferred by a link to a cam which drives the contacts, and which is also pivoted on the shaft. The face of the cam carries a washer riding on ball bearings, and the two heel contacts follow the wobbling surface of the washer as the shaft spins. The angle that the face of the cam makes with respect to the axis of the shaft is determined by the speed of the rotor and the pressure exerted by the adjustable coil spring against the weight. The heel contacts are spaced 90 degrees apart on the washer, Figure 6(b), hence energize successively the field windings which are 90 degrees apart and shunt the windings that are diametrically opposite.

If the rotor tends to go too fast the weight, as explained before, tends to turn more and more at right angles to the rotor axis.


FIELD COIL
ROTOR
CAM
LINK
WEIGHT
STATOR

(a) Cross-section of motor.

(b) Contact end of motor.

Figure 6. D-c. constant speed motor.

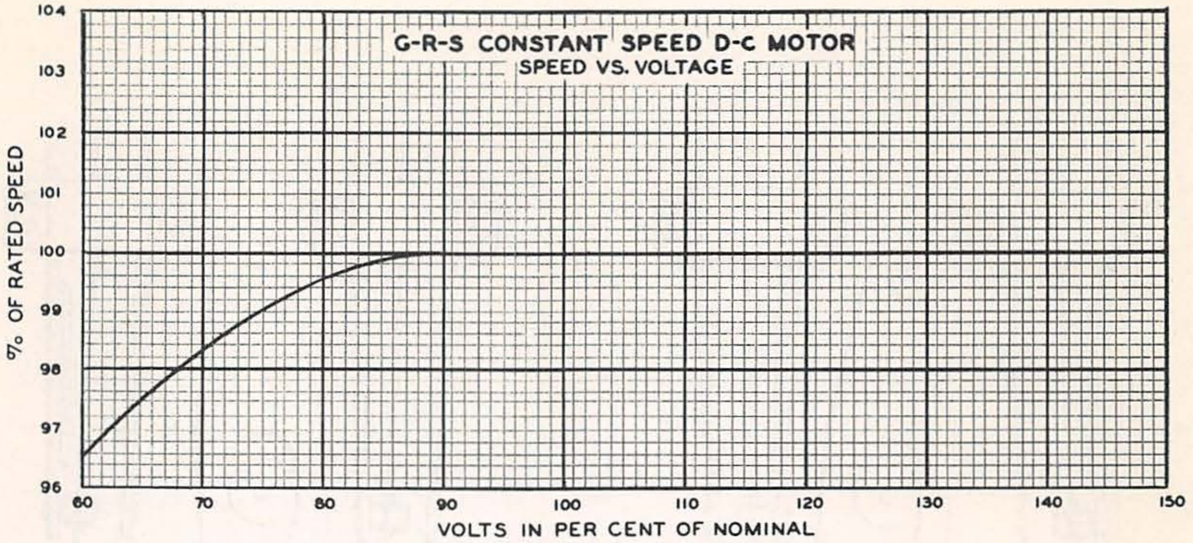


Figure 7. Speed versus voltage curve of d-c. motor.

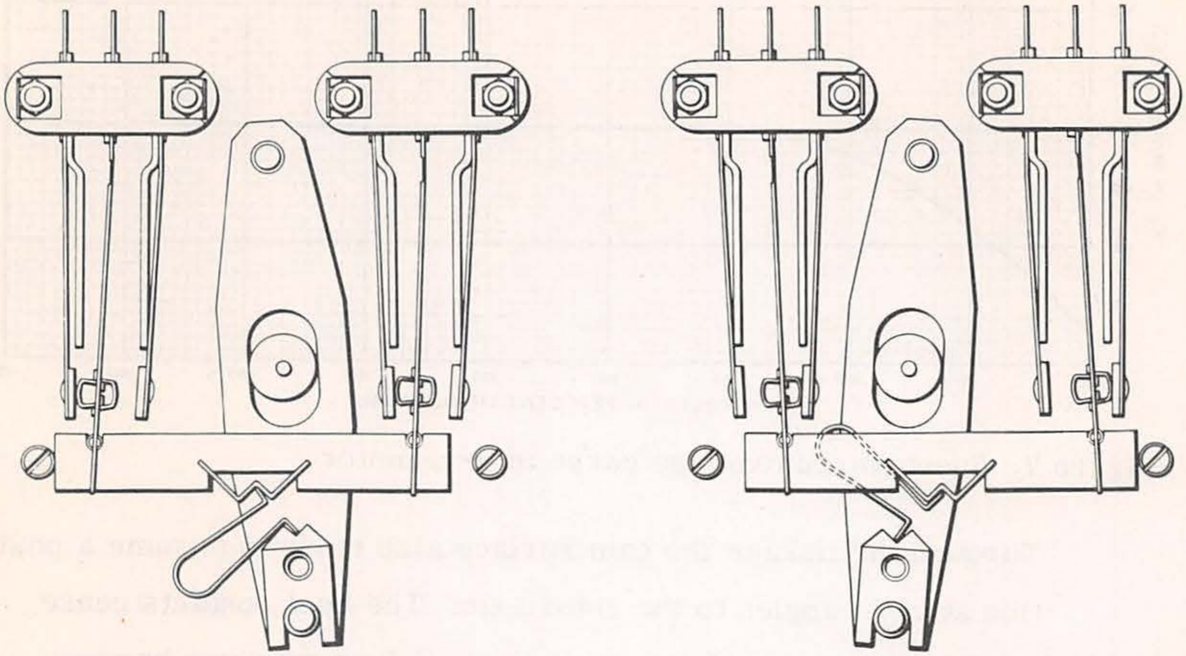
Through the linkage the cam surface also tends to assume a position at right angles to the rotor axis. The heel contacts cease touching the stationary contacts and all four windings become steadily energized and tend to lock the rotor, thus slowing it down.

If the rotor tends to go too slow the weight tilts the cam face towards the rotor axis thus causing the contacts to close earlier to set up the field sooner to pull the rotor around faster.

The speed regulation of the motor versus voltage variations is shown in the accompanying graph, Figure 7.

The direction of rotation is determined by the polarity at the motor terminals. The polarity is indicated on the wiring diagram. See "IV Internal Wiring".

Speed of output shaft	Voltage Variation	Rated Voltage	Current at rated volts (ma.)	Starting Volts	Time for 40 Revs. of shaft	Rotor speed in R.P.M.
40	7-9	8	250 to 270	2.4	60 sec. ± 2	600 ± 20
40	9-11.5	10	230 to 250	3.0	60 sec. ± 2	600 ± 20
40	10.8-13.2	12	195 to 215	3.5	60 sec. ± 2	600 ± 20



(a) Left-hand contacts closed. (b) Right-hand contacts closed.

Figure 8. Contacts are operated through a spring toggle.

C. Toggle

The spring toggle consists of a W-shaped spring snapped into place in a slot provided on the two contact pushers and a U-shaped toggle spring between the W-spring and the block on the toggle arm.

Figure 8 shows the toggle in its two extreme positions.

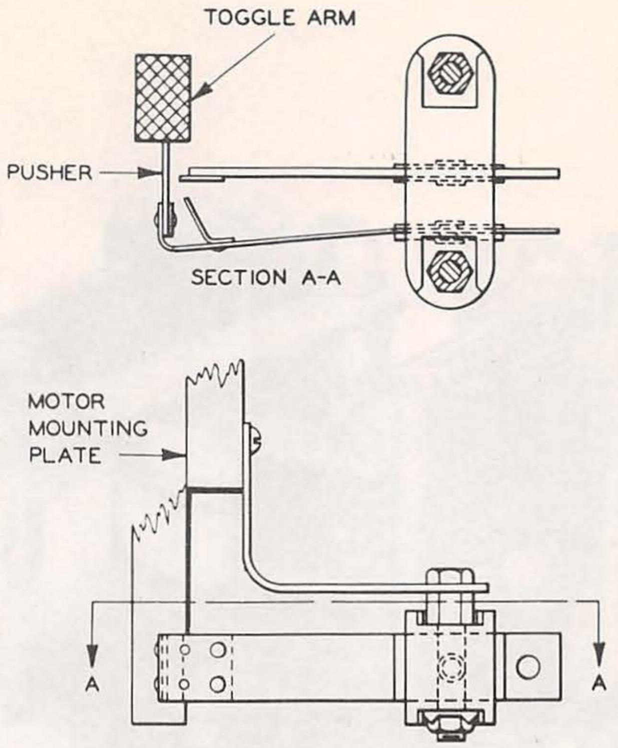

TOGGLE ARM
PUSHER
SECTION A-A
MOTOR
MOUNTING
PLATE
A
A

Figure 9. Biasing contact.

D. The Biasing Contact

The biasing contact Figure 9 is on a bracket supported from the motor mounting plate. A pusher rivetted to one contact member engages with the toggle arm when the arm swings over into the position shown in Figure 8(a).

Power is connected to the motor through the biasing contact even though the control circuit is opened, and as long as the toggle arm is not in position shown in Figure 8(a).

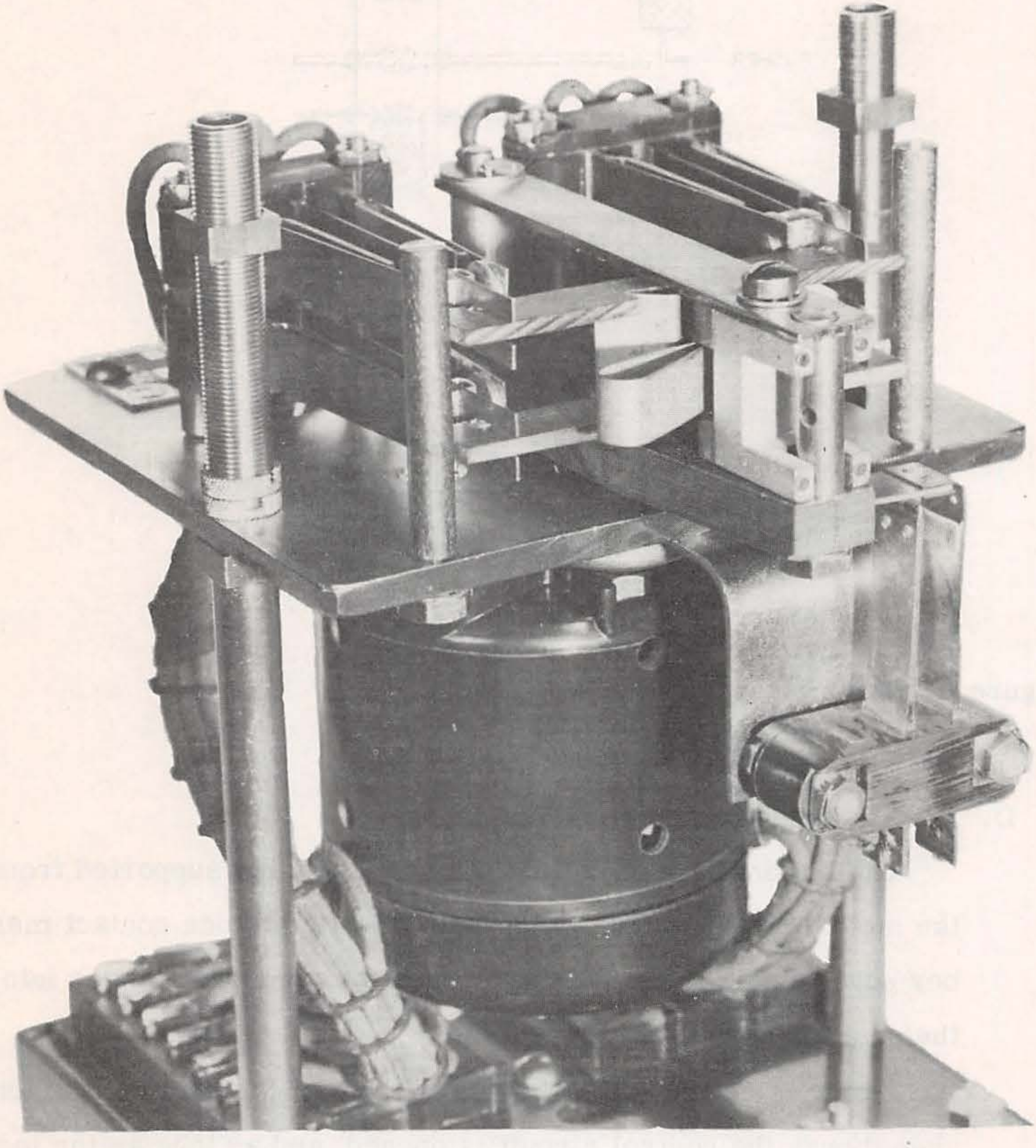


Figure 10. View underneath relay, showing close-up of toggle.

Figure 10 shows the underside view of the toggle arrangement and the biasing contact. In this view you can see the two contact pushers, the heavy-duty platinum-silver contacts, the two springs which make up the toggle, and the toggle arm.

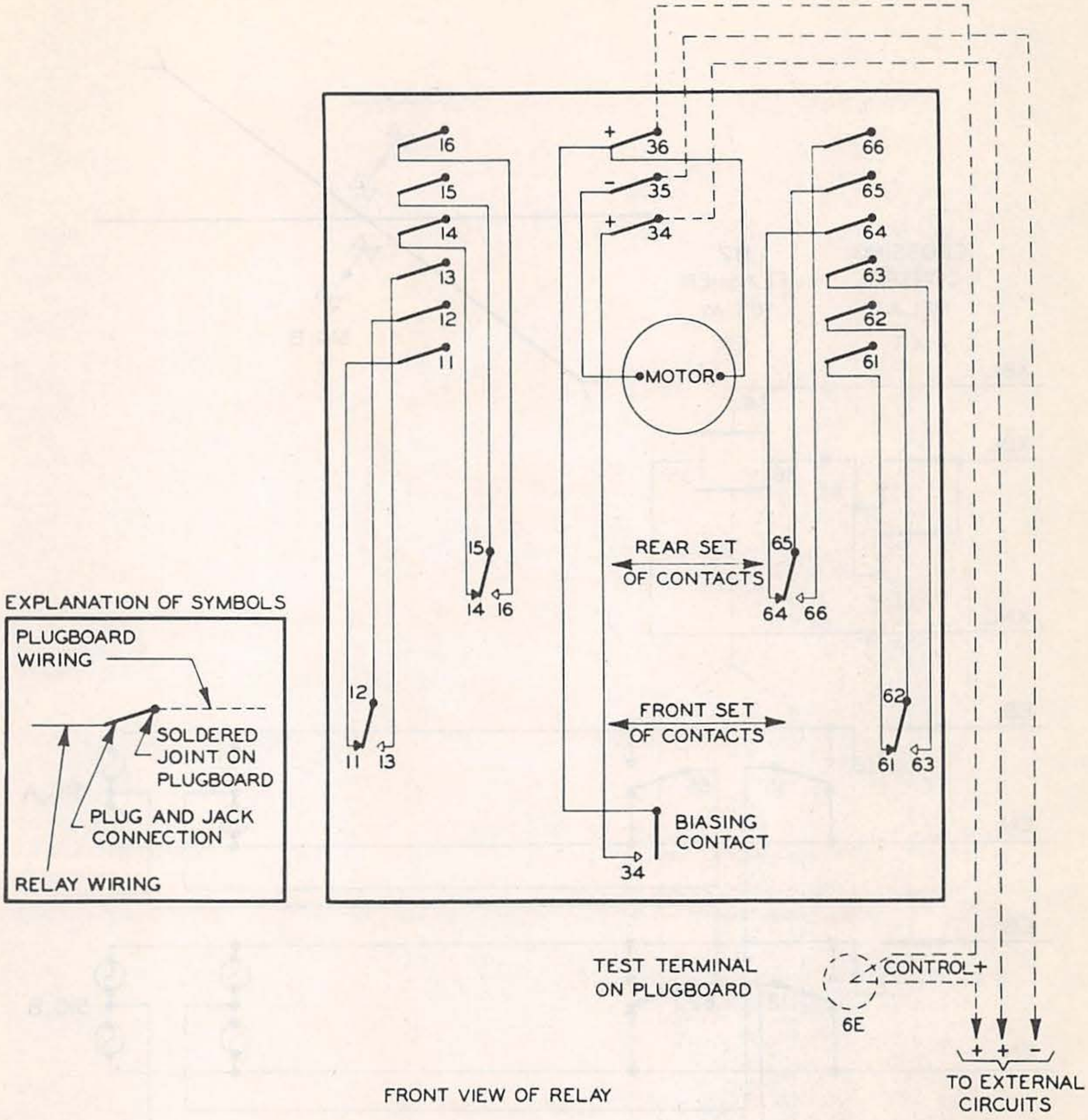

16
15
14
13
12
11
+
36
-
35
+
34
66
65
64
63
62
61
MOTOR
REAR SET OF CONTACTS
15
14 16
65
64 66
FRONT SET OF CONTACTS
12
11 13
62
61 63
BIASING CONTACT
34
EXPLANATION OF SYMBOLS
PLUGBOARD WIRING
SOLDERED JOINT ON PLUGBOARD
PLUG AND JACK CONNECTION
RELAY WIRING
TEST TERMINAL ON PLUGBOARD
CONTROL+
6E
+ + -
TO EXTERNAL CIRCUITS
FRONT VIEW OF RELAY

Figure 11. Internal wiring of Type B Size 2 motor-operated flasher.

IV. INTERNAL WIRING

The internal wiring is shown in Figure 11. The control circuit is carried through terminals 35 and 36, with plus on 36. Raw plus energy for the biasing feature is connected to terminal 34. Should the control plus be interrupted while the biasing contact is closed,

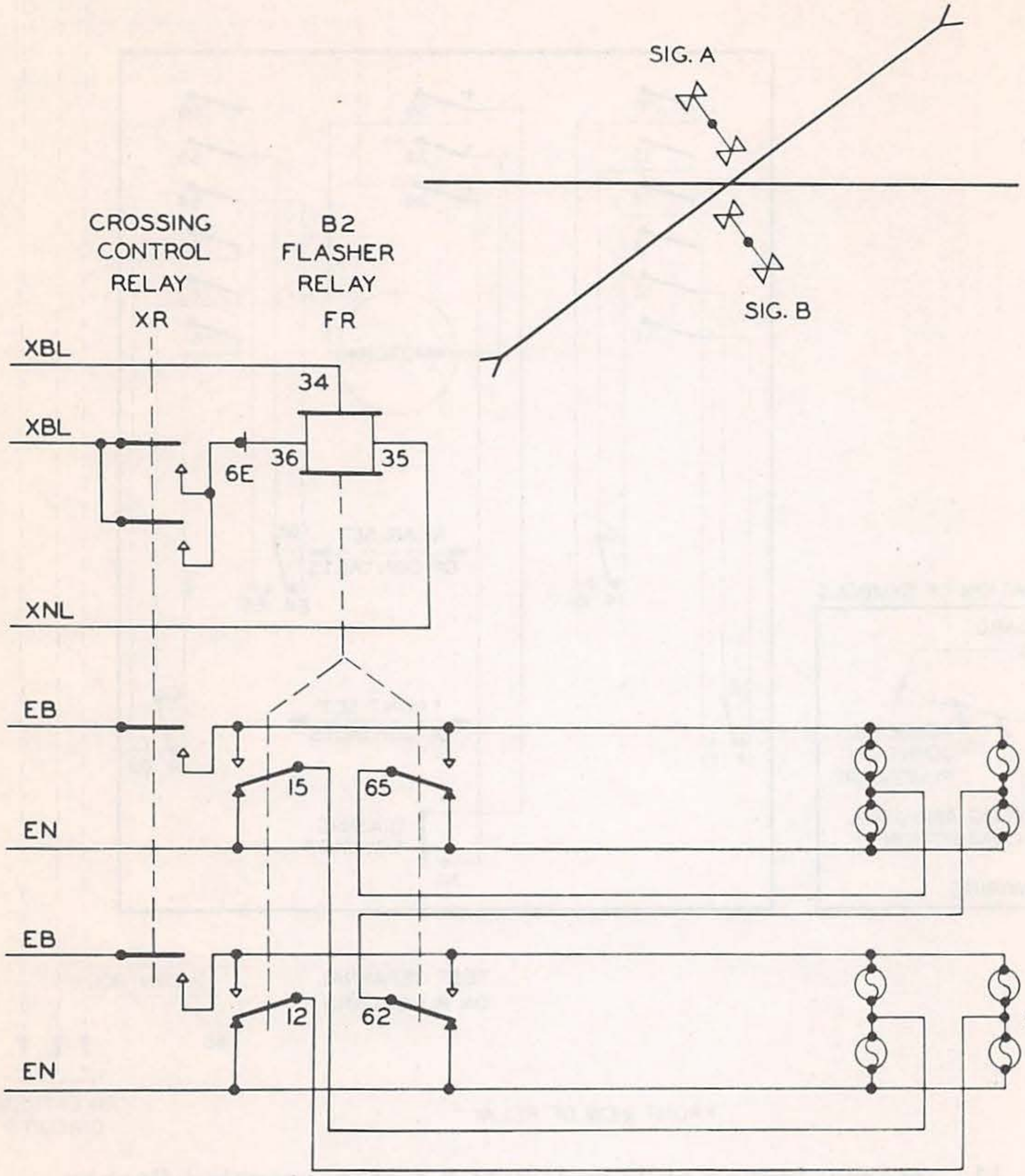

SIG. A
SIG. B
CROSSING CONTROL RELAY XR
B2 FLASHER RELAY FR
XBL
34
XBL
36
6E
35
XNL
EB
15
65
SIG. A
EN
EB
12
62
SIG. B
EN

Figure 12. Typical crossing light control circuit.

the raw plus will continue to drive the motor until the biasing contact opens, thus assuring that the same contacts are always closed when the relay is deenergized.

V. CIRCUIT APPLICATIONS

A. For Highway Protection

The highway crossing application circuit of the motor-operated flasher is shown in Figure 12. The light circuits are the same as for any standard flasher relay, the contacts being so connected to the lights as to place a shunt across each light alternately. The controlled positive energy is broken through the crossing control relay XR. Raw positive energy is applied directly to terminal 34. This last connection is optional and desirable since it causes the flasher to stop with the same set of contacts closed with full pressure.

B. For Block Signaling

Flashing signals for railway signaling purposes have been used on 20 major railroads according to a survey made by A.A.R. Signal Section Committee X (Signaling Practice).* The uses to which flashing lights have been put are:

1. For advance approach or medium speed indication, using a flashing yellow.
2. For slow restrictive indication, using a flashing yellow under one or more reds.
3. On dwarf signals for high speed proceed indication, using a flashing green.
4. For train order or manual block signals to distinguish from interlocking or automatic signals, by using flashing red, yellow or green.

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*See AAR Signal Section Advance Notice, Vol. XLI, No. 1, p. 262 and 301. Also AAR Signal Section Advance Notice, Vol. XLII, No. 1, p. 210-A and 268-A.

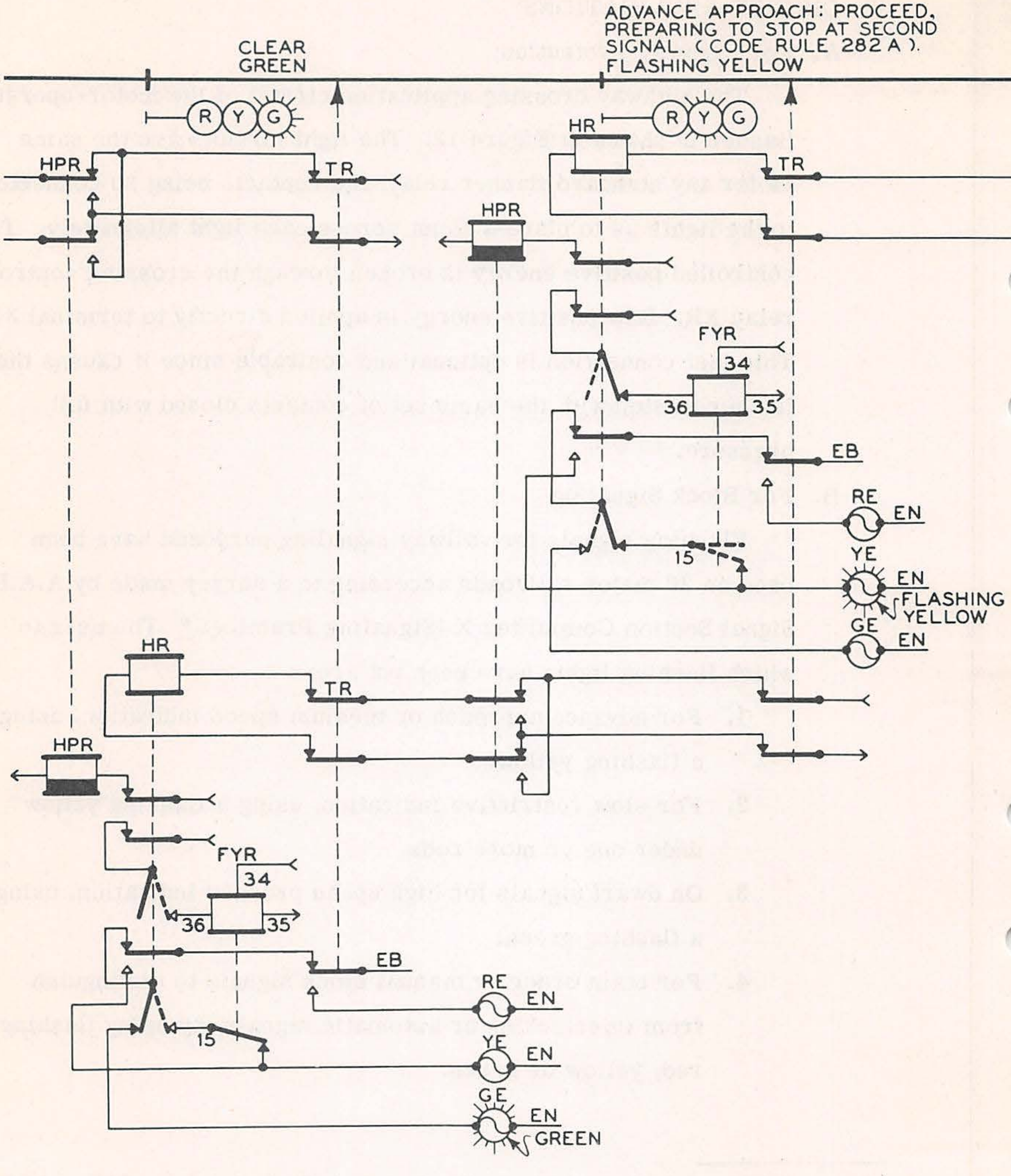
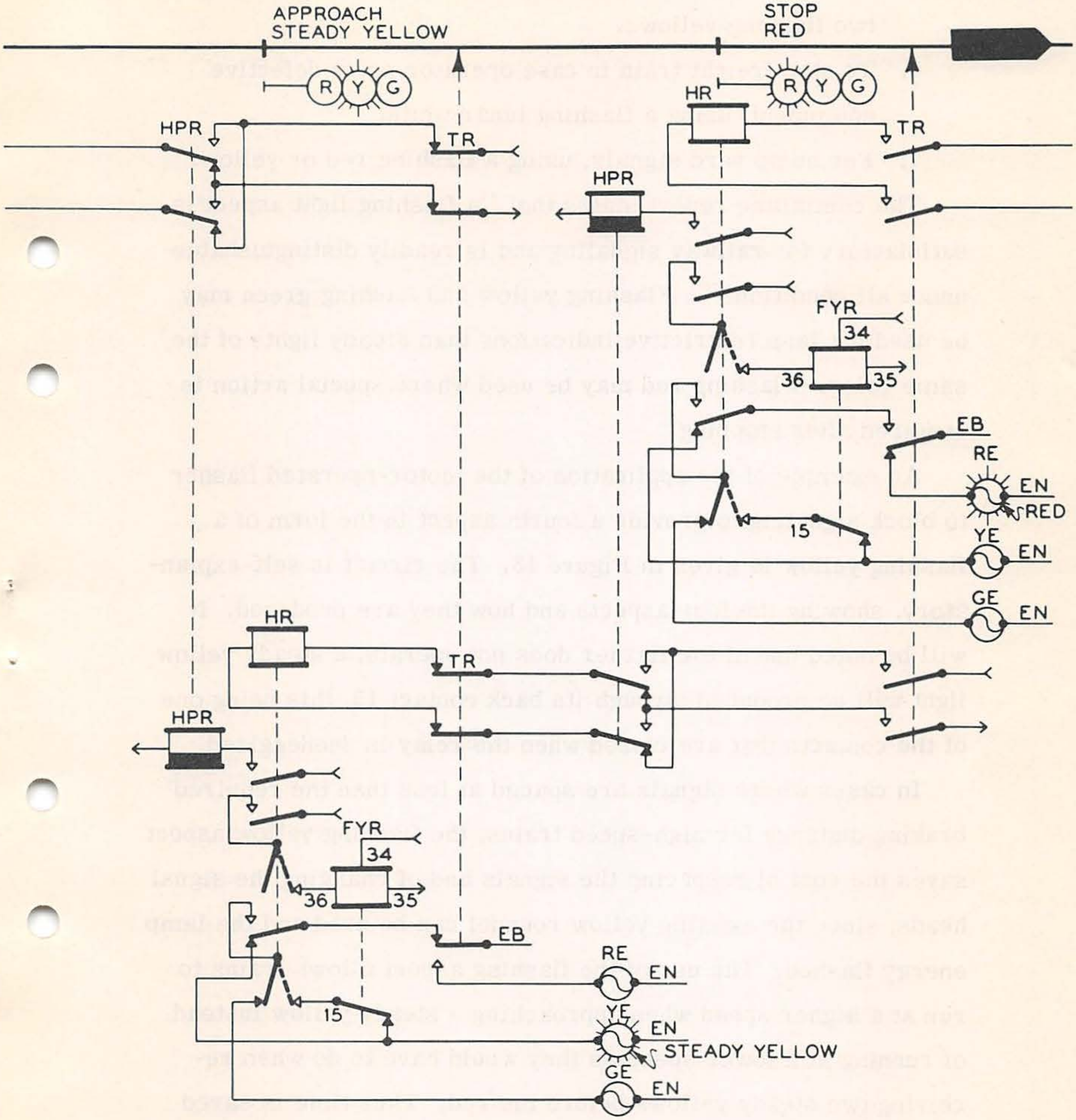

ADVANCE APPROACH: PROCEED, PREPARING TO STOP AT SECOND SIGNAL. (CODE RULE 282 A).
FLASHING YELLOW
CLEAR
GREEN
R
Y
G
HR
HPR
TR
FYR
34
35
36
EB
RE
YE
GE
EN
15
FLASHING YELLOW
GREEN

Figure 13. Application of Type B motor-operated flasher relay to block signaling to provide a flashing yellow fourth aspect.


APPROACH
STEADY YELLOW
STOP
RED
R
Y
G
HR
HPR
TR
FYR
34
36
35
EB
RE
EN
RED
15
YE
GE
STEADY YELLOW

5. To indicate dragging equipment, using a flashing red or two flashing yellows.
6. To stop freight train in case operator notes defective equipment, using a flashing lunar white.
7. For hump yard signals, using a flashing red or yellow.

The committee report states that "a flashing light aspect is satisfactory for railway signaling and is readily distinguishable under all conditions". Flashing yellow and flashing green may be used for less restrictive indications than steady lights of the same color. Flashing red may be used where special action is required after stopping.

An example of the application of the motor-operated flasher to block signaling to provide a fourth aspect in the form of a flashing yellow is given in Figure 13. The circuit is self-explanatory, showing the four aspects and how they are produced. It will be noted that if the flasher does not operate, a steady yellow light will be produced through its back contact 15, this being one of the contacts that are closed when the relay is deenergized.

In cases where signals are spaced at less than the required braking distance for high-speed trains, the flashing yellow aspect saves the cost of respacing the signals and of changing the signal heads, since the existing yellow roundel can be used and the lamp energy flashed. The use of the flashing aspect allows trains to run at a higher speed when approaching a steady yellow instead of running at a lower speed as they would have to do when receiving two steady yellows before the red. Thus time is saved and trains are spaced closer, thereby increasing track capacity on busy lines.

C. For Hump Yards

The application of the B2 flasher to hump yard signaling is shown in Figure 14. In this case a flashing red signal is given by the hump controller when a back-up move is required. Incidentally, note in the circuit the use of a rectifier in series with the primary of the signal lighting transformers to provide d-c. to energize the lamp repeater relays for indication purposes.

IX. TESTS AND ADJUSTMENTS

General instructions covering assembly, adjustment, test, handling and shipping the relay are covered by General Engineering Specifications GES 1-74.

Shop specifications and mechanical adjustments for the d-c. motor 56108-23 are given in ATS-DCM 10R-15.

X. ORDERING

The Type B motor-operated flasher, registered and gasketed, with the electrical biasing feature, and ball-bearing motor carries the following ordering references:

Normal Volts	Ordering References
8	57261-802 Gr. 2
10	" " Gr. 3
12	" " Gr. 4

* * *

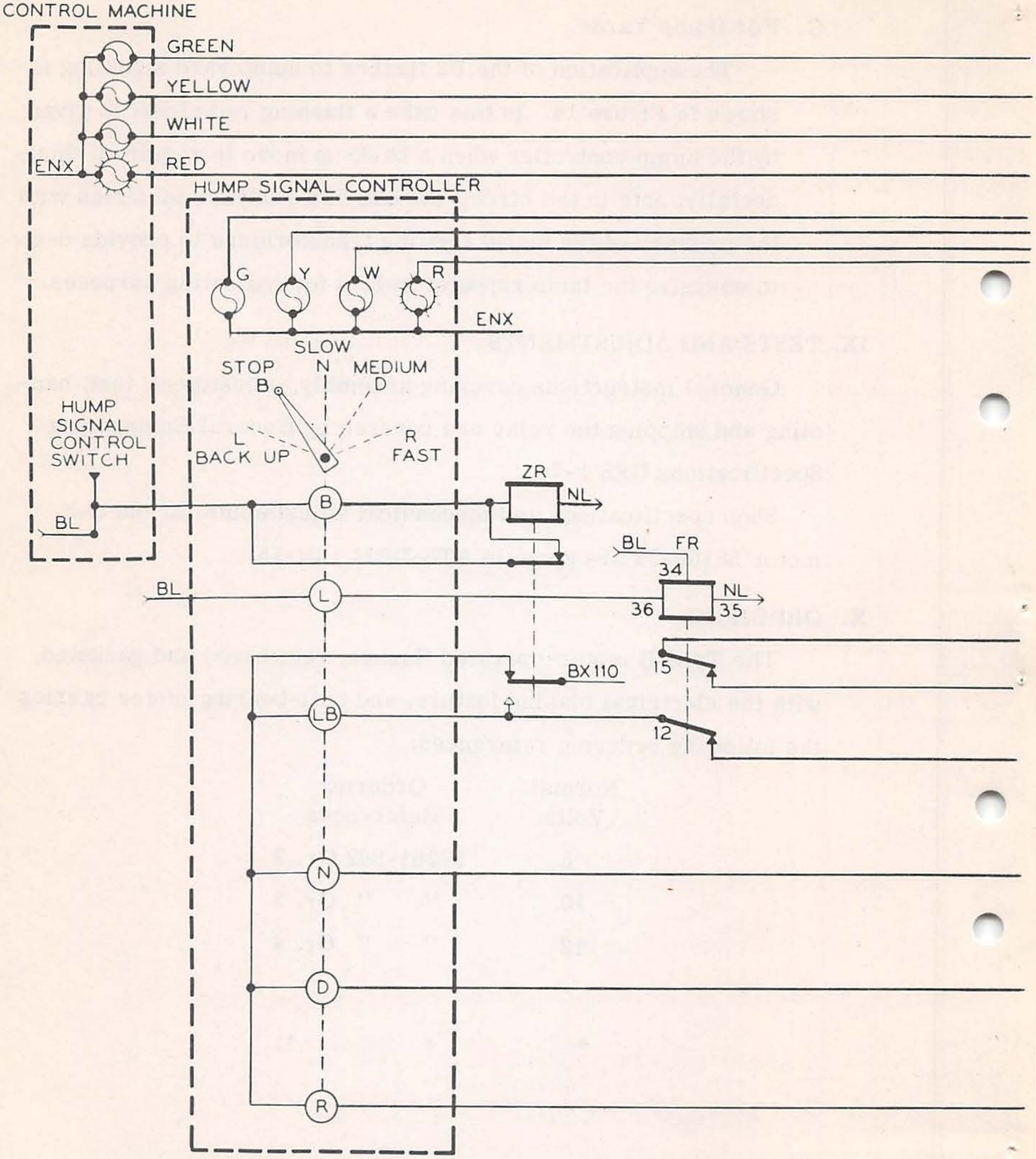
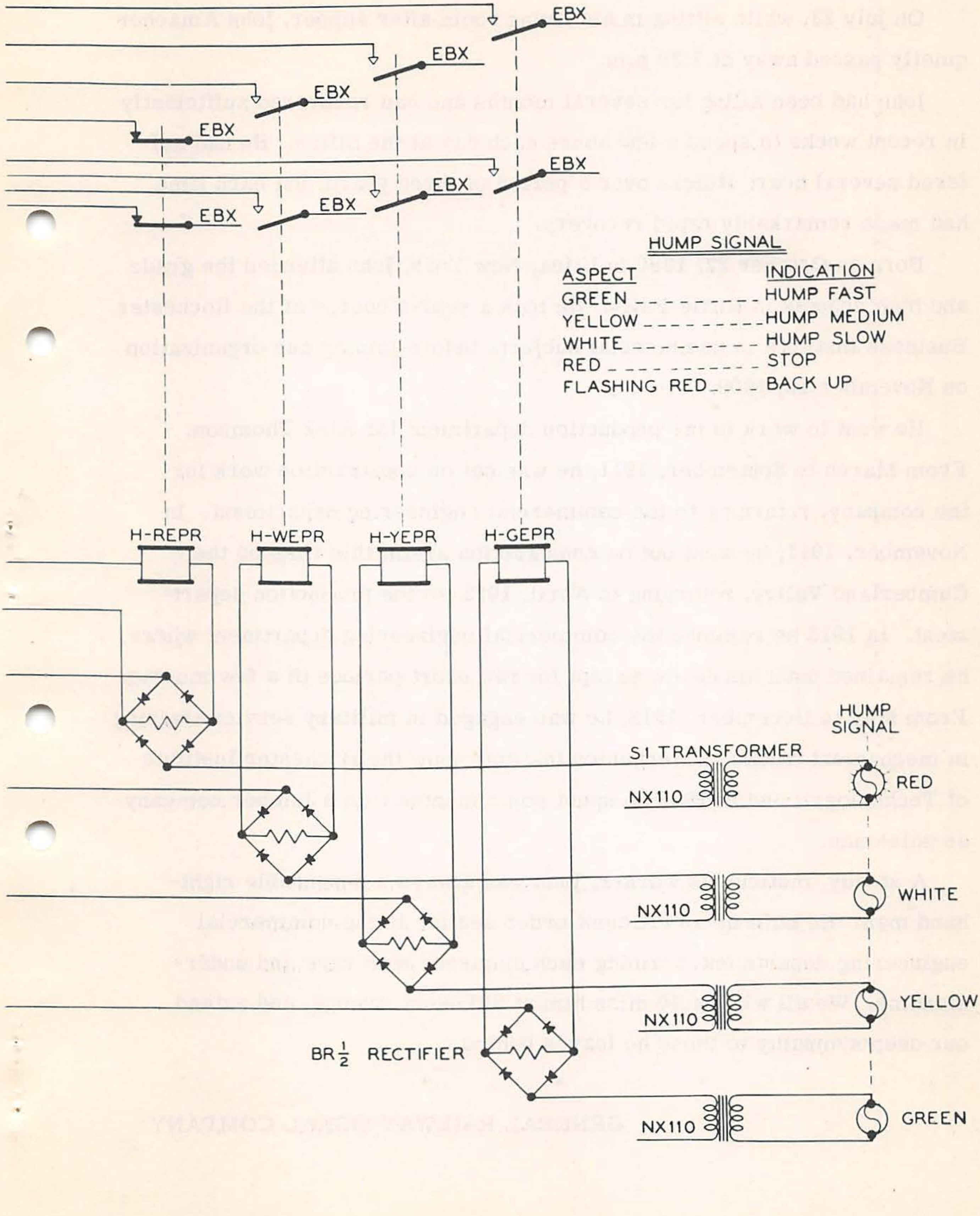

CONTROL MACHINE
GREEN
YELLOW
WHITE
ENX
RED
HUMP SIGNAL CONTROLLER
G
Y
W
R
ENX
SLOW
STOP
N
MEDIUM
B
D
L
R
BACK UP
FAST
HUMP
SIGNAL
CONTROL
SWITCH
BL
B
ZR
NL
BL
FR
34
BL
L
NL
36
35
15
BX110
LB
12
N
D
R

Figure 14. Use of a Type B motor-operated flasher in hump yards to provide a flashing red aspect.


EBX
EBX
EBX
EBX
EBX
EBX
EBX
EBX
H-REPR
H-WEPR
H-YEPR
H-GEPR
HUMP SIGNAL
S1 TRANSFORMER
NX110
RED
NX110
WHITE
NX110
YELLOW
BR½ RECTIFIER
NX110
GREEN

HUMP SIGNAL

ASPECT	INDICATION
GREEN	HUMP FAST
YELLOW	HUMP MEDIUM
WHITE	HUMP SLOW
RED	STOP
FLASHING RED	BACK UP

John Amacher Dies

On July 23, while sitting in his living room after supper, John Amacher quietly passed away at 7:30 p.m.

John had been ailing for several months and had recovered sufficiently in recent weeks to spend a few hours each day at the office. He had suffered several heart attacks over a period of three years, but each time had made remarkably rapid recovery.

Born on October 22, 1890 in Utica, New York, John attended the grade and high schools in Little Falls. He took a year's course at the Rochester Business Institute in commercial subjects before joining our organization on November 15, 1909.

He went to work in the production department for Alex Thomson. From March to September, 1911, he was out on construction work for the company, returning to the commercial engineering department. In November, 1911, he went out on construction again, this time on the Cumberland Valley, returning in April, 1912, to the production department. In 1913 he rejoined the commercial engineering department where he remained until his death, except for two short periods of a few months. From May to December, 1918, he was engaged in military service training in mechanical trades at Mechanics Institute (now the Rochester Institute of Technology); and in 1925 he spent some months with a lumber company as salesman.

A steady, meticulous worker, John was always a dependable right-hand man. He built up an efficient order section in the commercial engineering department, training each employee with care and understanding. We all will sadly miss him at 801 West Avenue, and extend our deep sympathy to those he leaves behind.

* * *

G-R-S NEWS
July 1947

New Unit-Wire Circuits Provide Route Check

Our unit-wire circuits up to the present have had one operating drawback. If an operator wished to change a route in the face of an approaching train and he had sufficient time to do it, he could put the home signal to stop, wait for the time element to run out (as indicated by the extinguishing of the lock light), then change the position of the switch and clear the home signal. If, however, the operator failed to wait for the lock light to go out, because of an oversight or from nervous hurry, his throwing the switch lever would have no effect, and, when he operated his signal lever, the home signal would promptly clear up over the route as originally lined up. The result would be to put the train on a wrong route, but a safe one nevertheless.

To guard against such manipulating errors the new circuit shown in the folded insert was devised. The principles are explained in the description that follows.

A. The Switch Control Circuit

The layout selected is a power-operated turnout and a full complement of signals. To illustrate the principles, we have shown the circuits required for a "far" group, that is, for the control of functions remote enough from the control machine to require line wires between the control office and the housing at the field location.

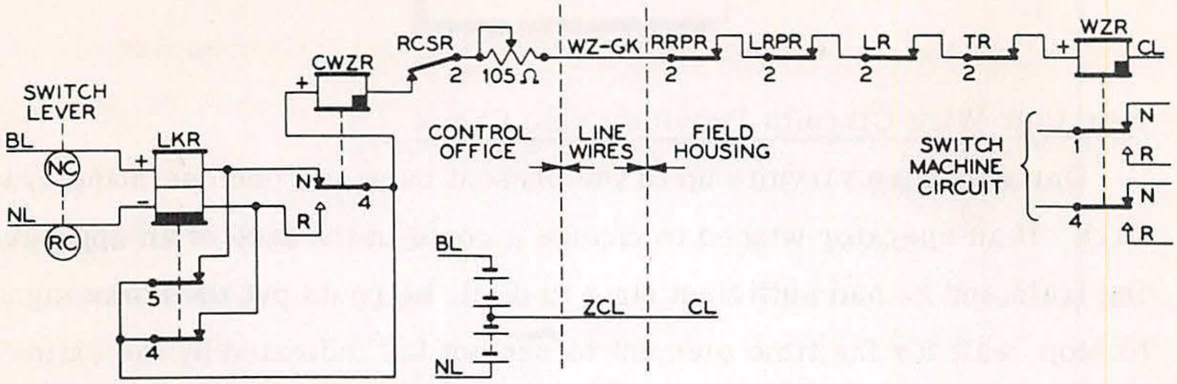

SWITCH LEVER
BL
NC
NL
RC
LKR
+
-
5
4
CWZR
+
N
R
4
RCSR
2
105 Ω
WZ-GK
RRPR
2
LRPR
2
LR
2
TR
2
WZR
+
CL
CONTROL OFFICE
LINE WIRES
FIELD HOUSING
SWITCH MACHINE CIRCUIT
1
4
N
R
N
R
BL
ZCL
CL
NL

Figure 1. The switch control circuit.

1. The relays in the circuit

(a) The switch control relay

In the switch control circuit the switch control relay, WZR, is a two-position magnetic-stick relay. It is used primarily to control the switch movement and enters into the control of the correspondence relays, NWCR and RWCR, described later.

(b) The correspondence switch control relay

The correspondence switch control relay, CWZR, is also a two-position magnetic-stick relay, and is connected in series with the WZR in the field. Its function is to provide a check on whether a switch movement has been called for by manipulation of the switch lever. It also prevents preconditioning of switch controls with a train on the detector track. Its contacts also enter into the switch out-of-correspondence indication, described later.

(c) The lock indication relay

The lock indication relay, LKR, is a two-winding neutral relay, slightly slow in releasing. It is normally energized.

When deenergized it provides a lock indication on the control panel. With the CWZR it prevents preconditioning, the stick contacts accomplishing this.

Contacts of the LKR enter into the track and switch indication circuits in the control office.

(d) The route check stick relay

A contact of the route check stick relay is in the switch control circuit. The RCSR is a standard neutral relay and is used only for far groups. It is normally deenergized and prevents a signal control from getting out into the field unless the switch control relay and the switch lever are in correspondence. This is the heart of these new circuits - the central feature that guards against the manipulating errors mentioned at the start of this article.

Whenever the RCSR is stuck up because of a cleared signal, further manipulation of the switch lever can produce no results.

(e) The red repeaters of the signals

The RRPR and LRPR are respectively the right and left signal repeaters, being energized when the signals are red. Contacts of these relays are in the WZR circuit to prevent any switch controls from being initiated unless all signals governing over the switch have been put to stop.

(f) The lock relay

The lock relay, LR, is normally energized and is used to prevent the movement of the switch whenever a signal is clear over the switch or the track circuits associated with the switch are occupied.

A contact of the LR is therefore in the WZR circuit to prevent the WZR from responding whenever any of the above conditions exist.

(g) The track relay

The introduction of a track relay contact in the WZR circuit seems at first glance to be redundant, as the same contact is in the control of the LR. The reason, however, for having the TR contact is to prevent an undesirable flash of the switch light on the control panel when the detector track is shunted. This is explained in detail on page 12.

2. Circuit Operation

When the operator reverses the switch lever, NL is connected to the lower winding of LKR. NL being at a lower potential than CL which is connected to WZR, current flows through WZR winding from right to left, forcing the reverse (R) contacts on this relay to close. The current path continues through contacts TR, LR, LRPR, RRPR, and RCSR, through the CWZR winding, forcing the R contacts on this relay to close also. Then through LKR front contact 4, the lower winding of LKR, switch lever contact RC to negative battery, NL.

Thus it can be seen that WZR and CWZR are in correspondence with one another. LKR is held energized during the reversal, and is deenergized only if RCSR and the field relay contacts in the circuit open up.

3. Circuit characteristics

The series relays are designed for operation on 12 volts. The line batteries are 24 volts center-tapped,which allow approximately 50 ohms line resistance in the circuit (control wire and common).

This is the equivalent of 50,000 feet of No. 10 line wire at 68°F., control and common, or 4-3/4 miles from the control office to field housing.

To compensate for lack of line resistance, a 105-ohm rheostat is inserted in series with the CWZR and the WZR, and can be adjusted in service for good relay operation without excessive drain on the battery.

B. The Route Check Stick Circuit, Signal Controls and Indications

As stated above, this is the one important addition to our unit-wire circuits which prevents the clearing of a signal over an unintended route, as explained at the start of this article.

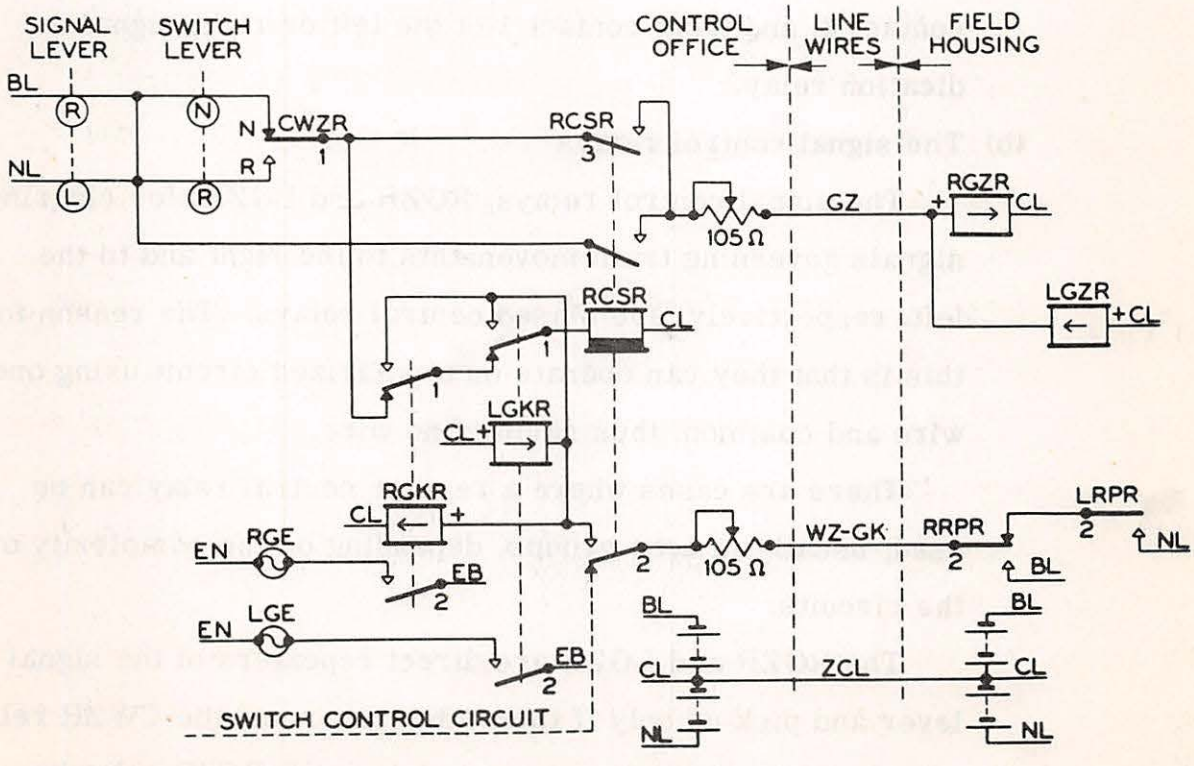

SIGNAL LEVER
SWITCH LEVER
CONTROL OFFICE
LINE WIRES
FIELD HOUSING
BL
NL
R
L
N
R
N
CWZR
1
R
RCSR
3
GZ
105 Ω
RGZR
+
CL
LGZR
+CL
RCSR
CL
1
1
LGKR
CL+
RGKR
CL
+
EN
RGE
EB
2
2
105 Ω
WZ-GK
RRPR
2
LRPR
2
NL
BL
BL
EN
LGE
EB
2
BL
CL
ZCL
CL
NL
NL
SWITCH CONTROL CIRCUIT

Figure 2. Route check stick, signal control and indication circuits.

1. The relays in the circuit

(a) The route control stick relay

This relay, RCSR, has already been described. It is a standard neutral relay with a slow-release action. It is normally deenergized. It is picked up whenever the signal lever is placed in the left or right position and the switch control relay is in correspondence with the switch control lever.

Once picked up, RCSR is stuck up through its own front contacts 1 and 3 and the signal lever left or right.

When the signal clear indication is received from the field and RGKR or LGKR picks up, RCSR is stuck up through back contact 2 of a signal red repeater relay, its own front contact 2, and front contact 1 of the left or right signal indication relay.

(b) The signal control relays

The signal control relays, RGZR and LGZR, for clearing signals governing train movements to the right and to the left, respectively, are biased neutral relays. The reason for this is that they can operate on a polarized circuit using one wire and common, thus saving line wire.

There are cases where a regular neutral relay can be used, usually in near groups, depending on the complexity of the circuits.

The RGZR and LGZR are direct repeaters of the signal lever and pick up only if the switch lever and the CWZR relay are in correspondence. A contact 1 on the RCSR relay bypasses the switch-call check to prevent manipulation of the switch lever from deenergizing a GZR and putting the signal back to the stop position.

(c) The signal indication relays

The signal indication relays, RGKR and LGKR, are energized when the corresponding signal clears and the associated red repeater of that signal is deenergized. The GKR is a biased neutral relay to enable us to connect the two relays to one line wire on a polarized circuit, thus saving line wire.

In addition to lighting the signal indication lamps on the control panel, these relays transfer the stick circuit of the RCSR from the control office to the field.

Where signal indications showing direction are not required, a single regular neutral relay can be used instead of the two biased neutral relays.

2. Circuit operation

It should be clear from the description of the functions of the relays in these circuits, how the circuits work. Before the RGZR or LGZR can be energized, it is imperative that the switch lever and the CWZR relay be in correspondence. This insures that the WZR in the field has responded to the switch call.

When the signal lever is turned either to the right or to the left, the RCSR picks up and relays the signal control through its own front contact 1 to the RGZR and LGZR. The RGZR will pick up if plus energy is applied on the wire marked plus in the circuit - that is, when the signal lever is turned to the right. LGZR will pick up when the wire marked CL is positive with respect to the other lead - that is, when the signal lever is turned to the left. Both relays cannot pick up at the same time on this polarized circuit.

A short interval elapses before the signal clears and the red repeater relay is deenergized. The transmission of the signal indication over the WZ-GK wire is essentially the same as the transmission of the signal control over the GZ wire. Again a polarized circuit is used to control the two biased neutral relays, RGKR and LGKR in the control office, BL or NL being connected to the wire through RRPR and LRPR.

RCSR is made slow in releasing to bridge the shift in the RGKR or LGKR contacts from back to front points when these relays pick up.

3. Circuit characteristics

Since the operation of the RGZR and LGZR is over line wire and involves line resistance, a 105-ohm rheostat is adjusted when the job is placed in service to give positive relay operation under the worst conditions encountered.

The maximum amount of line resistance that can be tolerated in this circuit is 50 ohms. The voltage (BL to NL) of the line batteries is 24 volts; the batteries are center-tapped.

There is no margin of time required between the manipulation of the switch lever and the signal lever. These two operations can be simultaneous.

C. Switch, Track and Lock Indication Circuits

The switch correspondence, track and lock indication circuits are carried over the WTK line wire.

1. The relays in the circuit

(a) The switch correspondence relays

The switch correspondence relays, NWCR and RWCR, are biased neutral relays which check correspondence between

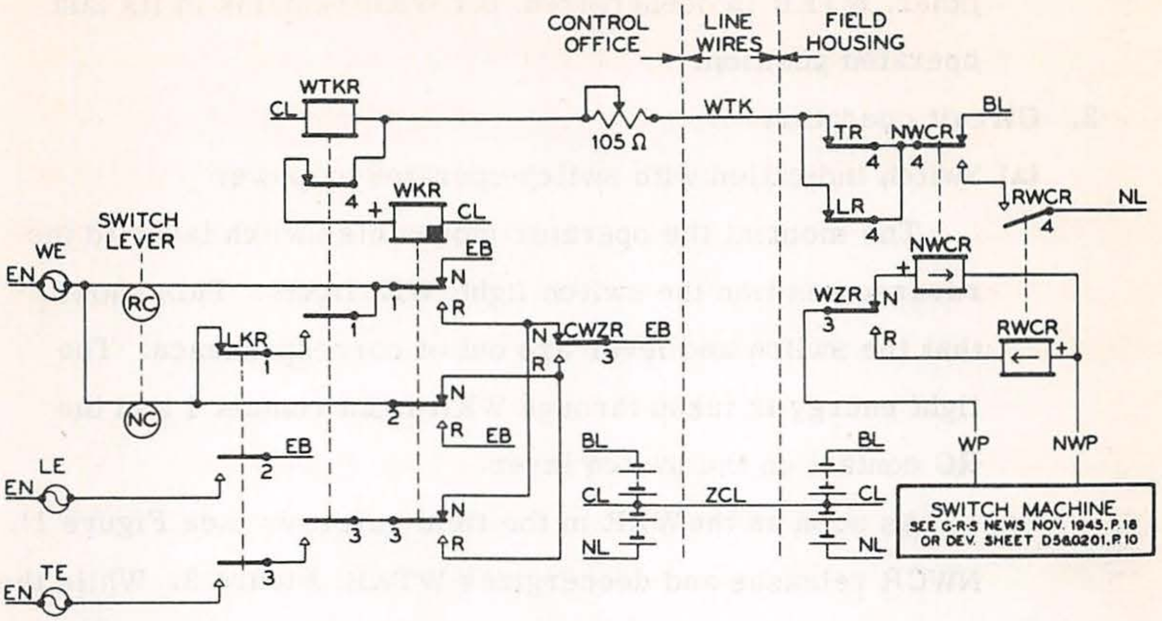

CONTROL OFFICE
LINE WIRES
FIELD HOUSING
WTKR
CL
105 Ω
WTK
BL
TR
NWCR
4
4
RWCR
NL
LR
4
WKR
+
CL
EB
SWITCH LEVER
WE
EN
RC
N
R
1
LKR
1
N
CWZR
EB
R
3
WZR
N
3
R
NWCR
RWCR
NC
N
2
R
EB
EB
2
BL
BL
WP
NWP
LE
EN
CL
ZCL
CL
SWITCH MACHINE
SEE G-R-S NEWS NOV. 1945, P.18 OR DEV. SHEET D580201, P.10
NL
NL
N
R
3
3
TE
EN
3

Figure 3. Switch correspondence, lock and track indication circuits.

the WZR and the position of the point detector in the switch machine. If both the WZR and the switch points are normal, the NWCR is energized. If reverse, the RWCR is energized.

(b) The switch and track indication relay

The switch and track indication relay, WTKR, is a standard neutral relay, normally energized from the field through the track, lock and switch correspondence relays. It shares one line wire with the switch indication relay, WKR; the circuit is polarized, and the WKR responds only if WTKR is energized.

(c) The switch indication relay

The switch indication relay, WKR, is a two-position magnetic-stick relay. It is connected to the polarized line circuit through front contact 4 of WTKR. The polarity is determined in the field by the NWCR and RWCR relays. During the time that the switch is moving from one position to the other, WTKR is deenergized, but WKR remains in its last operated position.

2. Circuit operation

(a) Switch indication with switch operated by power

The moment the operator moves his switch lever to the reverse position the switch light, WE, lights. This shows that the switch and lever are out of correspondence. The light energy is taken through WKR front contact 1 and the RC contact on the switch lever.

As soon as the WZR in the field reverses (see Figure 1), NWCR releases and deenergizes WTKR, Figure 3. While the switch is in transit, the WE light remains lit through WKR and the switch lever.

When the switch is over and locked reverse, RWCR picks up and applies NL to the WTK line. WTKR picks up and WKR reverses. Since CWZR reversed when the switch lever was placed reverse, the circuit to the WE light is opened, showing that the lever and switch are in correspondence.

(b) Switch indication with switch operated by hand

Assume for the moment that the operator has given permission for hand operation of the switch. As the switch unlocks the switch correspondence relay releases, and WTKR releases in the office. If the switch was normal before being hand thrown, then the WE light is lit during the out-of-correspondence condition through WKR front 1, WTKR back 1, LKR front 1, and NC contact on the switch lever.

If the switch had been reverse before being hand thrown, then the WE light is lit during the out-of-correspondence condition through WKR back 2, LKR front 1, WTKR back 1 and RC contact on the switch lever.

(c) Switch indication when WZR is not in correspondence with lever.

Assume the switch lever is reverse and the switch is also reverse, being left in that position by hand operation. Also assume that the WZ-GK line circuit is broken and WZR has not followed the lever. The WE light will show this condition of lack of correspondence between lever and control relay by lighting through CWZR front 3, WKR back 1, and the RC contact on the lever.

The same would hold true with the lever and machine in the normal position and CWZR reverse.

(d) Lock indication

At the moment the WZ-GK line is opened, LKR in the control office is deenergized and lights the lock light LE through LKR back 2. The line can be opened for a number of reasons; among them the LR deenergized, TR deenergized, LRPR and RRPR deenergized, RCSR up or the line broken. Any condition that electrically locks the WZR is indicated on the panel by the LE light.

(e) Detector track indication, switch normal

The TE light indicates when the detector track is occupied. With the switch locked normal, WKR is normal. When both TR and LR are deenergized, WTKR is deenergized in the office. The TE light is lit through LKR back 3, WTKR back 3, WKR front 3, and CWZR front 3.

(f) Detector track indication, switch reverse

The TE light is lit through LKR back 3, WTKR back 3, WKR back 3, and CWZR back 3.

(g) Detector track indication, switch in transit

If the detector track is shunted while the switch is in transit, there will not be a track indication. The WE and LE lights, however, will be lighted. When the switch locks up and proper correspondence relay picks up, there will be no indication relayed over the WTK wire since both LR and TR are down. Hence the WE and LE lights will stay lit as long as the detector track is shunted.

(h) Switch indication with detector track shunted

Should the switch be manually operated with the detector track shunted, no switch indication would be relayed into the office. As soon as the shunt is removed, however, the WTKR and WKR relays respond, and, if the switch and its control are out of correspondence, the WE light is lit. It will stay lit until the machine is brought into correspondence either by hand or by power.

3. Circuit characteristics

There is one characteristic in the WE light circuit that calls for an explanation.

Assume that the switch lever is normal, the CWZR is normal and the switch is normal. Now suppose the track is shunted, causing WTKR to drop. This would ordinarily cause the WE light to light through NC contact on the switch lever, LKR front 1, WTKR back 1 and WKR front 1. The light would be on for as long as it took LKR to drop in the office, hence would be just a flash. To avoid this, you will note in Figure 1 that a TR front contact 2 is inserted in the LKR-CWZR-WZR circuit to cause LKR to drop when TR opens. In the meantime WTKR is held up by LR front 4 momentarily until LR drops, as the result of TPR front 1 opening in the LR circuit (see folded insert for circuit). When LR drops and WTKR follows, the WE circuit is already open at LKR front 1, and we thus avoid the undesirable flash.

This circuit has been checked with high voltage in the office and low in the field, in an effort to disrupt the timing of the LKR and WTKR, but we find the flash does not occur under such adverse voltage conditions.

The above should serve to explain the reason for the seemingly redundant TR front 2 in the circuit in Figure 1.

The same sets of batteries are used for indication circuits as for control circuits. As explained before, the two sets of batteries are center-tapped and are nominally 24 volts (12-12). Other voltages can be used, but the voltage rating of the indication lamps on the control panel should be taken into consideration when it is planned to use the batteries for standby in case of a-c. power failure. At present lamps are available for operation on 4, 6, 8, 12, 16, 24, 35, 48 and 55 volts, according to the latest catalogs of lamp manufacturers. In the interest of standardization we would prefer to use only the 12- and 24-volt lamps.

D. Basic Line Circuits for Near Group

Where the group of controlled relays is "near", that is, contained within the same office or building as the control machine, and where there is no question of wire economy, the circuits shown in Figures 4, 5, 6 and 7 are used.

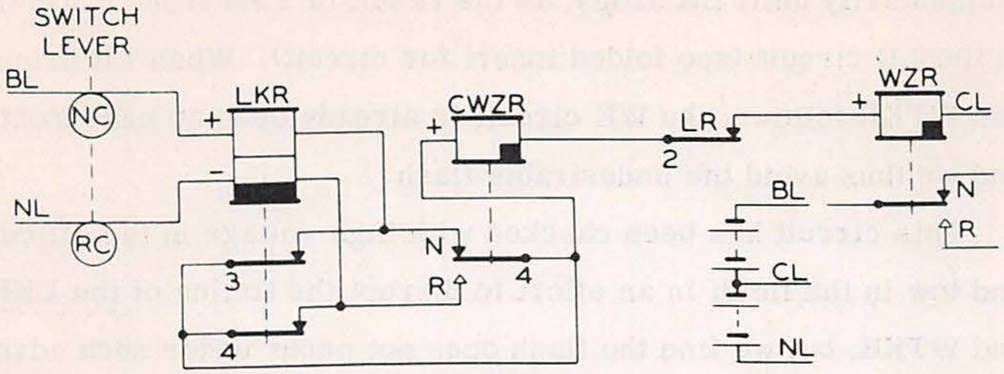

SWITCH
LEVER
BL
NC
NL
RC
LKR
+
-
3
4
CWZR
+
N
R
4
LR
2
BL
CL
NL
WZR
+
CL
N
R

Figure 4. Switch control relay circuit for a near group.

You will note that Figure 4 is very similar to Figure 1. The TR contact in the circuit, Figure 1, is omitted in Figure 4 as we do not run into the WE light flashes that we had with Figure 1, since the WE light control is different. See Figure 6.

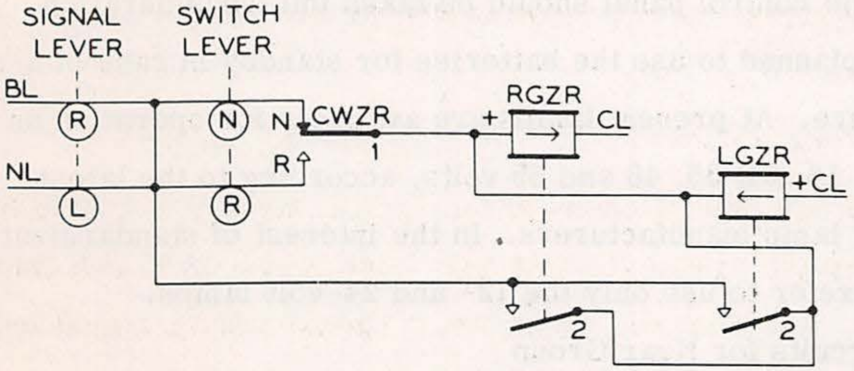
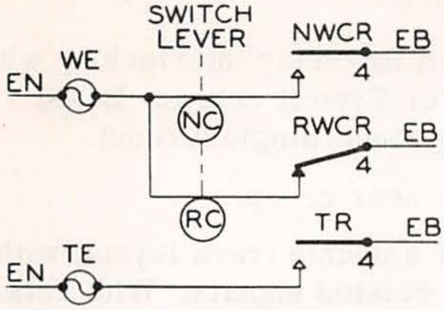

SIGNAL
LEVER
SWITCH
LEVER
BL
R
N
NL
L
R
N
CWZR
1
R
RGZR
+
CL
LGZR
+CL
2
2

Figure 5. Signal control relay circuit for a near group.

Because it is more economical to use wire than to use another relay, the RCSR relay is missing in Figure 5, which, otherwise, is similar to Figure 2. The stick circuits through fronts 2 of the GZR's are to hold the GZR's up should the switch lever be inadvertently manipulated after the signal has cleared.



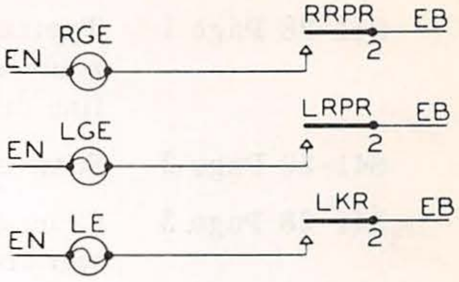


Figure 6. Switch and track indications for near group.

Figure 7. Lock and signal indications for near group.

The switch and track indication circuits, Figure 6, are much simpler for the near group than they are for a far group. The lock and signal indications are the same as for the far group.

E. Typical Circuits Available

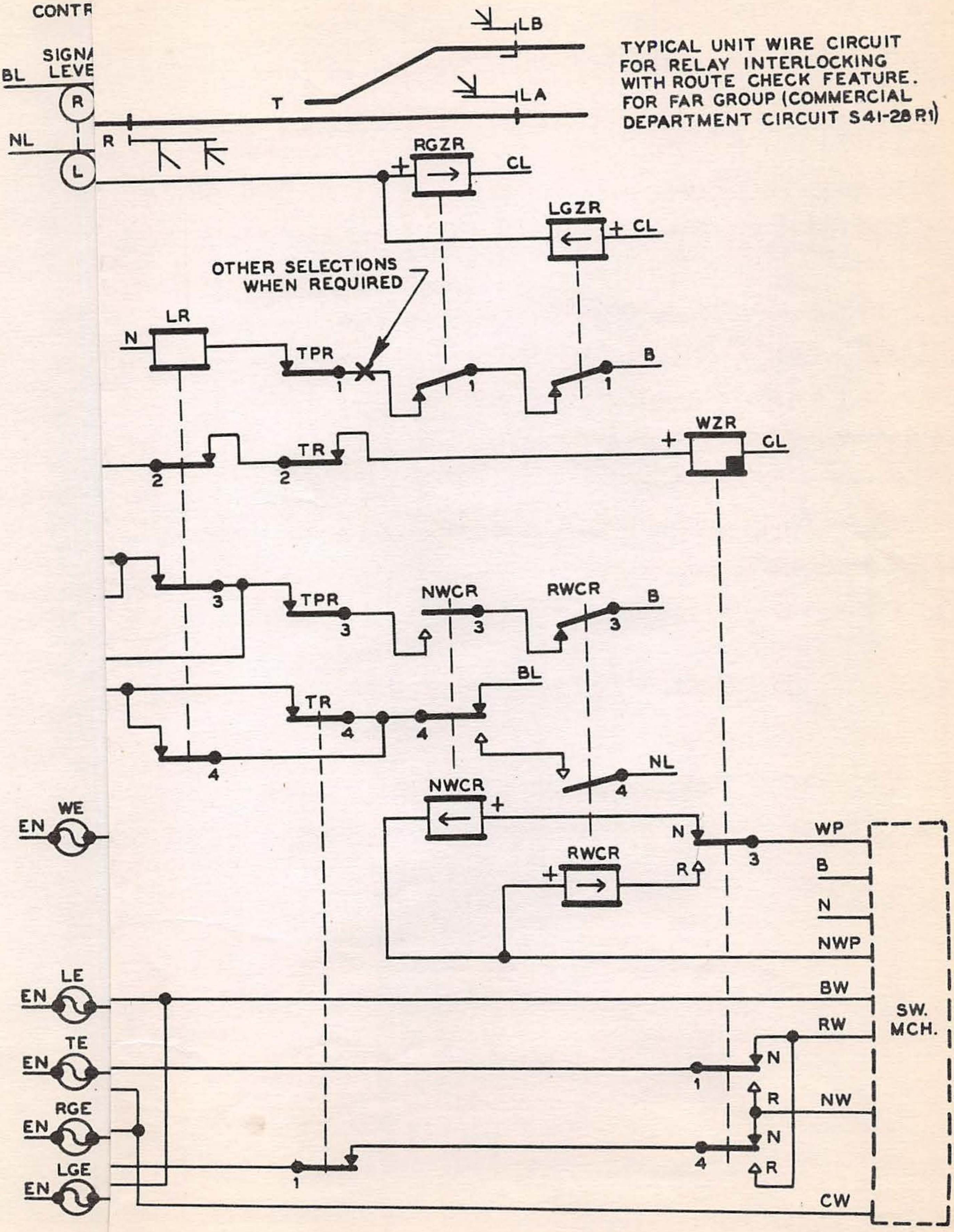
Since there are several panel arrangements usually required by different railroads, typical circuits have been prepared to suit these arrangements. For instance, some roads specify rotary signal levers in the track diagram for the control of the corresponding signals. Some prefer the signal control levers in a row below the track diagram. The rotary signal levers can have the "push-pull" feature with the "turn", or can be "turn" only. Switch position can be indicated by lights, or by means of a movable point indicator.

The following is a list of typical circuits with the Commercial Department's circuit number for reference:

S41-28 Page 1	Typical unit wire circuit for relay interlocking with route check feature. For Type K relays. Basic line circuits. For far group. Single turnout.
S41-28 Page 2	Same as page 1, but for near group.
S41-28 Page 3	Same as page 1, but for a double track layout, with two crossovers and associated signals. With rotary signal levers on the diagram.
S41-28 Page 3A	Same as page 3, but for far group, and with rotary signal levers having "push-pull" feature. For high signals only.
S41-28 Page 3B	Same as page 3A, but with all signal levers having the "push-pull" feature.
S41-28 Page 3C	Same as page 3, but using separate RCSR relays for left and right signals.
S41-28 Page 4	Typical circuits for turn signal levers and GZR, CGZR relays for a near group consisting of a double track layout with two crossovers and associated signals.
S41-28 Page 4A	Same as page 4, but with push-pull-turn signal levers.
S41-28 Page 5	Typical circuits for G, ES, WS, L, LS, and AS relays at a double track layout with two crossovers and associated signals.
S41-28 Page 6	Typical circuits for TPS, YGP, RP, and signal mechanism control for same double track layout as on S41-28 page 5.

Blue print copies of these circuits can be obtained from the Commercial Department. All these -28 circuits are for Type K relays. The -27 circuits are for Type B relays.

* * *



TYPICAL UNIT WIRE CIRCUIT FOR RELAY INTERLOCKING WITH ROUTE CHECK FEATURE. FOR FAR GROUP (COMMERCIAL DEPARTMENT CIRCUIT S41-28R1)

CONTR
SIGNA
LEVE
BL
NL
R
L
LB
LA
T
R
RGZR
+
CL
LGZR
+ CL
OTHER SELECTIONS WHEN REQUIRED
LR
N
TPR
1
1
1
B
WZR
+
CL
TR
2
2
3
TPR
3
NWCR
3
RWCR
3
B
BL
TR
4
4
4
NL
4
NWCR
+
RWCR
+
N
R
3
WE
EN
WP
B
N
NWP
LE
EN
BW
RW
SW. MCH.
TE
EN
N
R
1
NW
RGE
EN
N
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4
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Hermon Ober Retires

Hermon Patterson Ober, engineer in charge of estimating in the Commercial Department, retired July 1 after 24 years of continuous service with G-R-S in Rochester, and, prior to that, 14 years with Federal in Albany.

Born in Garrettsville, Ohio, on December 29, 1881, he attended the grade and high schools of his birthplace. He graduated with a B.S. degree from Hiram College, Hiram, Ohio, in 1905, where, two years before, our Sedgwick Wight had graduated. These two men, having met in college, were destined to be life-long friends, working side by side for about 26 years.

Mr. Ober's railroad career began in 1901 repairing freight cars in the Wilson Avenue (Cleveland) Yard of the Erie. In 1903 and again in 1905, after graduating from college, he worked for the Lake Shore and Michigan Southern (now New York Central) on surveying. Meeting up with his college friend, S. N. Wight, who was signal inspector by this time, he transferred to the signal department in 1905 as a circuit engineering draftsman. H. P. and S. N. roomed together in Cleveland and burned the midnight oil studying the Hall normal-danger gas-operated signals, the early Union motor signals, and detector, route and approach locking circuits. In 1907 the L. S. and M. S. had contracted with the Union Switch and Signal Company for block signaling on the western portion of the road between Cleveland and Chicago, and H. P. was employed on this construction work.

After the financial panic of 1907 when outside construction work was stopped, he joined the Illinois Central as signal draftsman in Chicago. Working for chief draftsman Al Moore, he became acquainted with office engineer Ed Larry and draftsmen Bob Phinney and Herbert Morgan, now signal engineer of the I. C. Shortly afterwards he went to the I. C. C. as field inspector for the "Block Signal and Train Control Board", testing trip type stops on the C.B. and Q.

In 1909 he joined the Federal Signal Company in Albany, New York, doing circuit engineering and estimating. In 1923, when the Federal Company combined with G-R-S, he was transferred to the G-R-S main office in Rochester, working on estimates under S. N. Wight, who was commercial engineer. H. P. has been associated with G-R-S steadily up to his retirement. He has been in close touch with all types of railway signaling developments, especially their application to railroad operation.

In his retirement Mr. Ober sees a busy future. He is going to live near Albany (RD Box 150, East Greenbush). With time left over from gardening, farming, cabinet making and fishing, he will visit his three married daughters and six grandchildren who live in Ohio, New York, and Massachusetts.

That we will miss him goes without saying, but we take keen pleasure in wishing him a very happy time in his retirement which he has so justly merited. We all look forward to his making G-R-S a stop-over point when visiting his Ohio daughter.

* * *

GENERAL RAILWAY SIGNAL COMPANY

G-R-S NEWS
September 1947

Silicones and Signaling

You have no doubt seen and read the current information on silicones and have wondered where they could fit into the railway signaling picture. You may also be interested in knowing what research and testing have been done in our laboratories on these new and strange products.

I. WHAT ARE SILICONES

Silicones are a series of substances, basically and chemically new, which vary all the way from fluids to rubbery solids. In chemical composition they differ from organic materials in many of their physical and chemical properties. In the organic carbon-hydrogen compounds, the "backbone" of the compounds can be expressed in its simplest form as a carbon chain written thus: $-\underset{|}{\overset{|}{c}}-\underset{|}{\overset{|}{c}}-\underset{|}{\overset{|}{c}}-$. In the silicone compounds the backbone is similar to the one found in glass and mineral silicates. The quartz-like skeleton is a series of alternating silicon and oxygen atoms which, in the simplest form, can be written thus: $-\underset{|}{\overset{|}{si}}-o-\underset{|}{\overset{|}{si}}-$.

Research in organosilicon compounds started back in 1871. It was only during World War II, when we were hard up for natural rubber, that concentrated research was started on these compounds. The commercial development of continuous glass filaments for insulation brought about the need for insulating resins and varnishes to fill voids and keep out moisture, yet stand up to high temperatures, in order to get the most out of the glass insulation.

II. SILICONE COMPOUNDS AVAILABLE

The following is a short list of silicone products which are now available:

1. Insulating resins and varnishes.
2. Thermosetting or laminating resins.
3. Coating resins and paints.
4. Rubber in the form of sheets, rods, tubing, and molded parts.
5. Oils and greases for both low and high temperature work.

These products exhibit general characteristics of stability under heat, inertness to water, metals, and chemicals, and good electrical properties. They extend the range of service temperatures well beyond the limit of organic products.

A. Insulating Resins and Varnishes

Silicone resins and varnishes have been used to bond and impregnate insulations of mica, fibrous glass, and asbestos. Used in electric motors, they have made possible higher service temperatures, with resultant higher horsepower ratings, or more complete enclosing of motors exposed to corrosive gases, liquids, and explosive vapors. A 10-horsepower motor occupies the space of a 3-horsepower motor built with the usual insulation. A trolley car motor insulated with silicone resins was run for 3,000 hours at 482°F., which is said to equal 400 years of service.

With silicone resins service temperatures of electrical devices have been raised 100°F. or more. Accelerated tests have shown that effective life is 10 to 20 times that of previous classes of insulation.

B. Thermosetting or Laminating Resins

Laminates of silicone-glass cloth and silicone-asbestos cloth have been produced and tested. They offer resistance to arcs, to high temperatures, and exhibit good electrical properties.

C. Coating Resins and Paints

Announced in 1946, these resins and paints were being tested during the World War II. A colorless silicone coating resin, usable over a temperature range from -40°F. to 400°F., was applied as a waterproofing compound on aircraft ignition cable junctions and radio and radar connectors. It has high dielectric strength, and resists corona cutting. It makes waterproof and adheres well to any ceramic, metal or rubber surface coated with it.

In metal-working, silicone liquids are being used as spatter release agents in welding. Highly polished surfaces are protected by a coating of silicone liquid to prevent spalls from marring the surface. The paint was used as protective coating for furnace parts, oven doors, smoke stacks, and exhaust manifolds. General Electric claims that silicone paint indefinitely retains its original color and gloss. The paint should be ready in about five years for use as surface finishes of automobiles, electric ranges, and hospital equipment. It is highly resistant to severe weather conditions, chemicals, and heat, and will prevent discoloration by hot greases, fruit juices, iodine, and several chemicals.

D. Rubber

Silicone rubber, given the trade name "Silastic" by the Dow Corning Corporation, behaves like conventional rubber except that it retains its elasticity at temperatures of 500°F. and over, whereas other rubbers decompose. Silicone rubber also remains flexible at -70°F.

Gaskets, diaphragms, grommets, washers, seals, and packings made of molded silicone rubber resist permanent set under compression at high temperatures. They regain 87 to 94 percent of their original thickness after being compressed to 75 percent of their original thickness for 6 hours at 300°F.

Silicone rubber resists weathering. It does not become hard or brittle or crack after long exposure to air, ultra-violet rays, and ozone. It possesses very good insulating properties.

It is available in the form of sheets, rods, tubes, and molded parts.

E. Oils and Greases

Silicones oils and greases are particularly well adapted to both low and high temperature work, because they exhibit these characteristics:

1. Small change in viscosity with temperature.
2. Stability at high temperatures in contact with air.
3. Chemical inertness.

The comparison of silicone oil viscosity with petroleum oil viscosity is given in the table below:

VISCOSITY - TEMPERATURE CHANGES
IN SILICONE AND PETROLEUM OILS

Temperature Degrees F	Viscosity, Centistokes at 100 F	
	Silicone Oil	Petroleum Oil (100 Viscosity Index)
210	40	10.8
100	100	100
0	350	11,000
-35	660	230,000
-70	1560	-------

The stability of silicone oils in contact with air at their atmospheric boiling points (about 800°F.) and their low vapor pressures at temperatures below their boiling points make them ideally suitable for use in high vacuum diffusion pumps.

In the presence of air at temperatures around 300°F., silicone oils remain free from discoloration, acid formation, sludging, and oxidation. They have no effect on copper, brass, bronze, aluminum, magnesium, iron, steel, tin, lead, cadmium or chromium, even after heating at 300°F. for many weeks in the presence of air.

Silicone oils have been used as damping fluids in instruments, as hydraulic fluids, and as heat transfer and thermal expansion fluids. They have given good service in aircraft instruments. They are, however, lacking in chemically active constituents which adhere to metal surfaces and so protect the surface when the oil film is ruptured. Compared to mineral oils, silicone oils are poor lubricants wherever boundary lubrication is necessary (iron or steel surfaces sliding on iron or steel surfaces), and especially where extreme pressure conditions are involved in the lubrication system.

Silicone greases have been used in the ball bearings of pumps handling molten caustic. Service temperatures of these greases range from -50°F. to about 400°F. Inert chemically, insoluble in water, these greases have been used on plug cocks in high pressure and high vacuum lines. The lines can be flushed out with live steam without melting out the grease.

III. PRICES

And here is the rub! In 1945-46 the following were the prices of silicone products:

Resins	$3 to 4 per pound.
Varnishes	$15 per gallon on the basis of 50% solids.
Ceramic treating solution	$0.38 to 0.48 per pound.
Silicone rubber	$3 to 4 per pound.
Silastic sheets	1/8" thick 8" x 8" weighing 0.43 lb. $6.85 or $15.90 per lb.
	1/8" thick 20" x 20" weighing 2.71 lbs. $29.75 or $11.00 per lb.
	1/8" thick 24" x 24" weighing 3.9 lbs. $45.50 or $11.65 per lb.
Silicone fluids	$6 per pound or $48 per gallon.
Silicone greases	$6 to 7 per pound.

Prices are somewhat higher this year.

IV. MANUFACTURERS

Dow Corning Corporation in Midland, Michigan.

General Electric Company, in Schenectady, N. Y. now constructing additional facilities at Waterford, New York.

V. BIBLIOGRAPHY

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VI. G-R-S TESTS

We have devoted our tests chiefly to the silicone lubricants. The paints, varnishes, and rubbers have not been tested by us. Our conclusions on the lubricants are:

1. For the general lubrication of all types of metal combinations, the petroleum oils are still to be preferred because they contain active groups which adhere to and protect the metal surfaces. Also, the petroleum oils are considerably less expensive.
2. The inert nature of the silicone oils, in addition to their small viscosity change with change in temperature, and their very low pour points indicate that they may have a field of usefulness where maximum lubricating qualities are not required and where petroleum oils are not satisfactory. If further development of the silicone oils should result in the adding of "oiliness" constituents without impairing inertness and resistance to oxidation, this type of oil would no doubt find considerable use as a non-corrosive lubricant.
3. At the present time the use of silicone oils is somewhat restricted since they are available only for limited commercial use.

Samples of silicone rubber received in our laboratory indicate that this material cannot be obtained at present in as soft a grade as is obtainable in crude or synthetic rubbers of other types.

Possible future uses for silicone materials in our apparatus are:

1. Lubricating oils of almost constant viscosity for small motors and fine instruments.
2. Varnish treatment of coils subjected to high temperatures.

3. Gaskets made of silicone rubber for cases and housings and apparatus covers.
4. Silicone coating on fiberglass products for high temperature applications.
5. Flexible mica insulation bonded with silicone resin for windings.
6. Silicone insulation on wire and cable in place of rubber.
7. Silicone insulation in our transformers to permit higher operating temperatures and higher ratings for the same size.

* * *

Duplex Plating for Relay and Signal Parts

Plating investigation begun in our laboratory in October, 1940, has revealed that a coat of tin over cadmium greatly improves resistance to corrosion. This process is known as "duplex plating" and is, as its name implies, the plating of a surface twice. The materials used, of course, need not be limited to tin and cadmium---duplex plating can also be tin over copper, nickel over copper, etc. We have found after many tests that tin over cadmium is the superior combination for protecting signal and relay parts made of steel and subjected to organic vapors, moisture, salt, and sulphurous fumes. The internal steel parts of such devices are now being plated in this way.

Here is the story of the investigation which will give you some idea of the quality of the cadmium-tin duplex plating.

A. The Tests

Panels, approximately 3 inches by 6 inches of auto-body sheet steel, and silicon steel cores were plated with nickel, cadmium, and tin, both single coating and duplex in several combinations. They were then exposed to seven tests.

1. Salt spray atmosphere.

   The plated parts were supported on glass racks hung from glass rods in the salt-spray chamber. A 5 percent solution of sodium chloride was circulated through the chamber and sprayed at 10 pounds air pressure against a glass baffle plate located in the front of the chamber. This prevented direct impingement of the spray on the parts. Glass trays were placed under the plated parts to prevent the drips from entering the salt solution reservoir. The spray was operated 8 hours each day. When not spraying, the chamber was kept closed to retain the moist atmosphere. The chamber was opened only for inspecting the plated parts and for renewing the salt solution.

2. Sulphur dioxide atmosphere

   The plated parts were suspended from glass racks under a bell jar in an atmosphere of moisture and sulphur dioxide gas. A stream of sulphur dioxide gas was passed through 250 cc. of water in a beaker for a period of 30 seconds, and the beaker placed under the bell jar. Tests were made at room temperature and the parts were examined daily.

3. G-R-S paint fence.

   The plated parts were racked on the G-R-S paint fence (on the office roof) and examined daily. After several months' testing, parts were removed, washed thoroughly, and examined for rust and corrosion products. They were then replaced on the fence to continue the tests.

4. Laboratory atmosphere.

   The plated parts were exposed in the chemical laboratory and examined at regular intervals.

5. Moist atmosphere.

The plated parts were suspended from glass hooks under a bell jar in a moist atmosphere maintained at room temperature. Examinations were made a regular intervals.

6. Alternate immersion and drying.

The plated parts were suspended from racks and immersed to half their length in tap water. The water level was kept constant to establish a definite water-air line to observe corrosion at that line. Parts were immersed for 8 hours, removed, and allowed to dry for 16 hours. This cycle was continued throughout the test. Fresh water was used daily.

7. Oleic acid atmosphere.

The plated parts were subjected to organic vapors in a heated oven. The duplex cadmium-tin parts were scratched to observe the effect of the vapors in the scratch marks.

B. The Results

The plating on the panels and cores was considered as having failed when approximately 10 percent of the surface had rusted.

In general it was found that tin plating over cadmium plating showed much better resistance to corrosion in all atmospheres than any other electroplated coating. Cadmium plate from 4 to 5 ten-thousandths of an inch thick was next best.

Tin plating over cadmium plating prevented the formation of the white growth which forms on cadmium plated parts when they are exposed to an atmosphere containing vapors from fatty oils or acids.

The results of each of the tests in brief follow.

1. Salt spray test.

After 4-1/2 months' exposure (3240 hours) there was less than 5 percent of the surface of steel panels rusted that were duplex plated with cadmium-tin. All other platings (except cadmium) failed after a maximum time of 3300 hours.

After 2-1/2 months' exposure (1800 hours) there was less than 5 percent of the surface of silicon steel cores rusted that were duplex plated with cadmium-tin. All other platings (except cadmium) failed after a maximum time of 1080 hours.

2. Sulphur dioxide test.

After 17 days exposure the cadmium-tin plated panels failed. The panels plated with tin alone to the same thickness as the cadmium-tin duplex plate failed after 11 days. Heavier coatings of tin failed after 21 days. The heavier tin coatings, however, cannot be applied to signal and relay parts because of the excessive build-up on the edges of the steel parts.

The cadmium-tin duplex plating on the steel cores outlasted other platings. Cadmium was a close second.

3. Paint fence test.

The steel panels duplex plated with tin over cadmium took 26 months to reach the failing point. All other platings failed before this time.

On silicon steel cores, cadmium and cadmium-tin proved equally good, failing after approximately 8 months and after other platings had failed.

4. Lab atmosphere test.

Steel panels duplex plated with tin over cadmium showed no signs of rust after 3 years' exposure. All other platings, except nickel over cadmium, allowed rust to start in this period, but none reached the failing point.

5. Moist atmosphere test.

After 2 years' exposure to this test, duplex plated panels (tin over cadmium) showed the least rusting of all platings tested. Cadmium was the next best.

6. Immersion - drying test.

It took approximately a month's exposure to this test to create rust on 3 percent of the surface of the duplex plated panels. All other platings failed in a matter of a few days, except cadmium, which failed in 27 days.

7. Oleic acid vapor test.

After 4 months' exposure in an oven at 150°F., the panels duplex plated with tin over cadmium showed no white growth such as appears on cadmium plating. There was very slight growth in the scratches made in the duplex plated surfaces.

Two Type CR relays with cadmium-tin duplex plated magnetic parts were placed in service in the Moffat Tunnel in 1942. Examination of these relays 3 years later showed no evidence of rust or other corrosion products.

The U. S. and S. Co. has been duplex plating tin on cadmium for about 2 years, as far as we know.

The cost of duplex plating is approximately double that of single plating.

* * *

GENERAL RAILWAY SIGNAL COMPANY

G-R-S NEWS
October 1947

Biased-Neutral Controller for Switch Machines

The biased-neutral switch machine controller, Figure 1, has been designed to take the place of all present controllers such as illustrated on pages 1001 to 1017 of Handbook 24 and in Catalog Section J, Part 31.

It permits two-wire polarized control, either normally energized or normally deenergized.

As may be seen in Figure 1, the new controller consists of an aluminum case provided with a terminal board and containing two biased-neutral contactors and an overload relay.

The new controller differs from former models in that no master relay is required to insure integrity of response to polarized control.

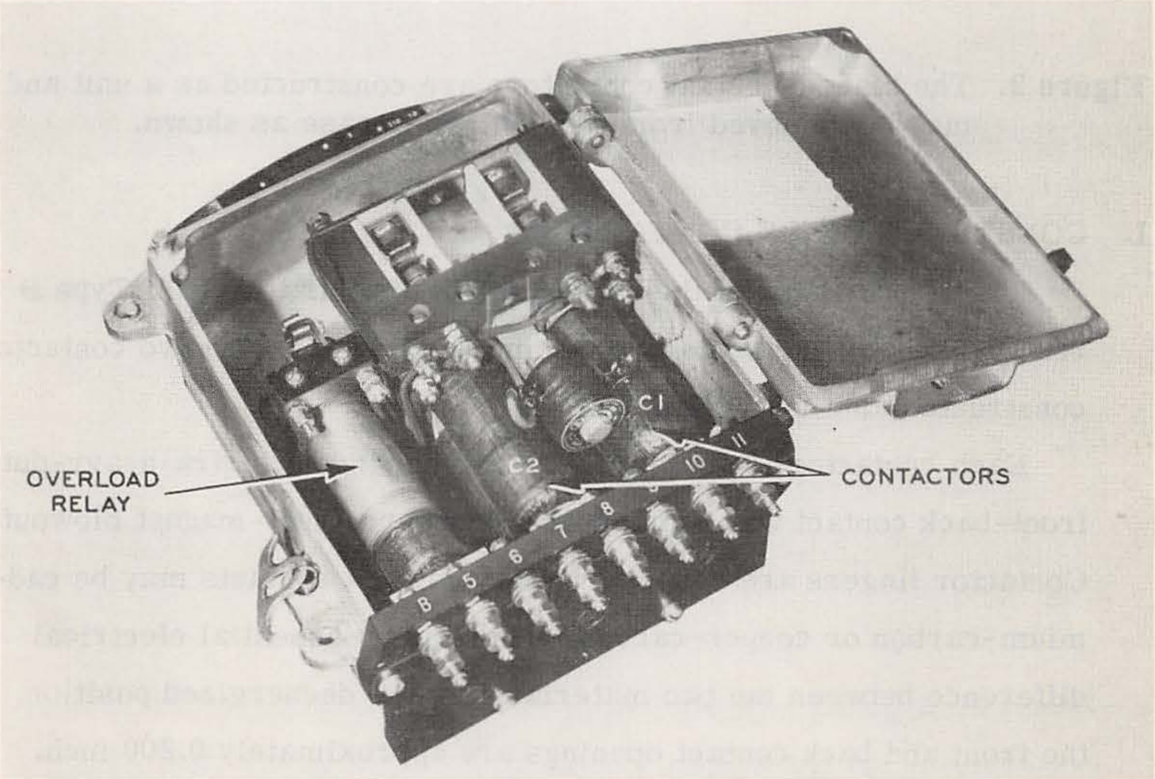


Figure 1. Biased-neutral controller.

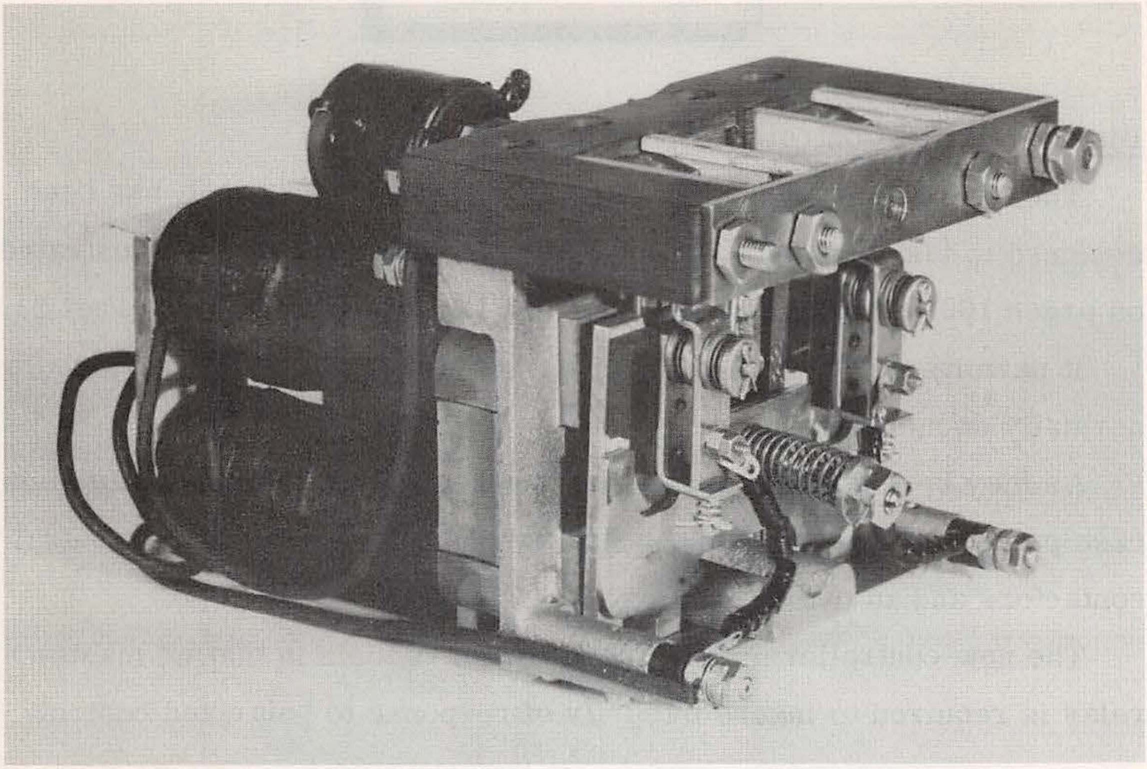


Figure 2. The biased-neutral contactors are constructed as a unit and may be removed from the controller case as shown.

I. CONSTRUCTION OF CONTACTORS

The construction of the contactors is similar to that of Type B relays, some of the same parts being used. There are two contactors, constructed as a unit, Figure 2.

Each contactor is equipped with one dependent, extra-heavy-duty, front-back contact which incorporates a permanent-magnet blowout. Contactor fingers are copper. Front and back contacts may be cadmium-carbon or copper-carbon. There is no essential electrical difference between the two materials. In the deenergized position, the front and back contact openings are approximately 0.200 inch. Total contact opening is approximately 0.400 inch.

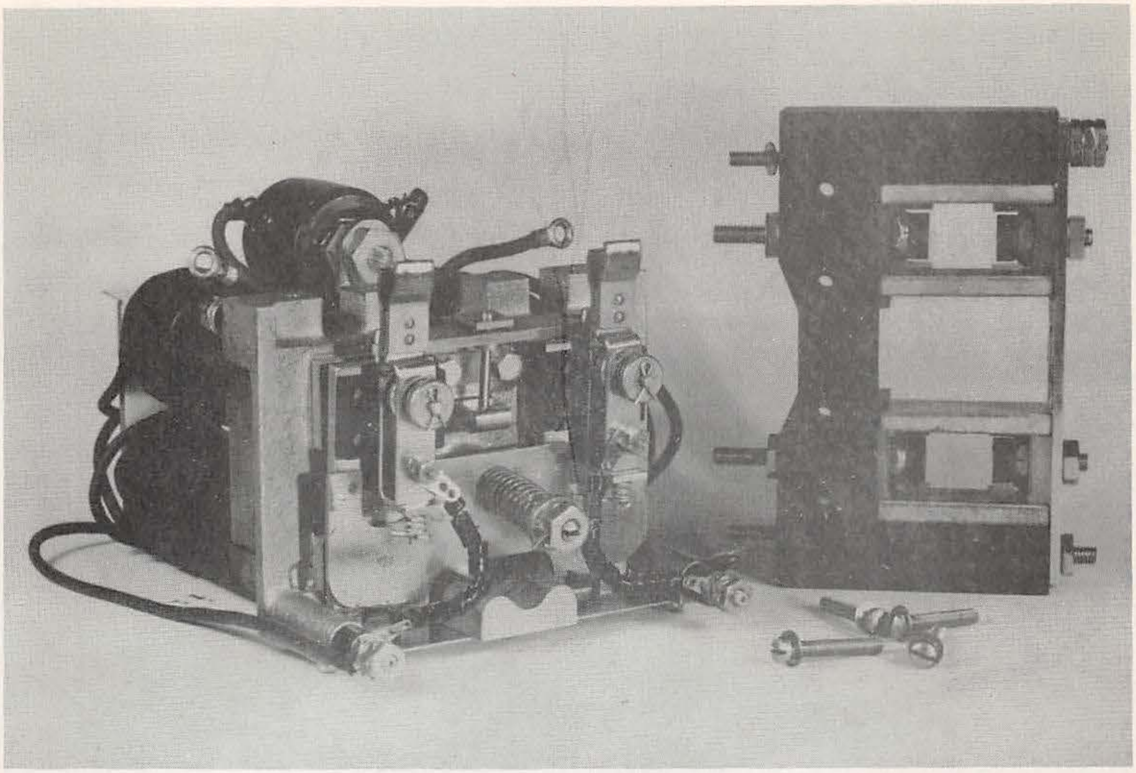


Figure 3. The front and back contact structure can be removed from the contactor unit in one piece, without disturbing adjustment of contact fingers.

Figure 2 illustrates the unit construction of the contactors and shows them removed from the terminal board, to which they are fastened by four 5/16-24 cap screws, 1-5/8 inches long. Figure 3 shows how the front-back contact structure may be removed from the contactors as a unit, without disturbing the adjustment of the contact fingers.

II. CENTERING DEVICE

A new and improved centering device connecting the two contactor armatures causes the finger of each contactor to assume a central position between front and back contacts whenever both contactors are deenergized.

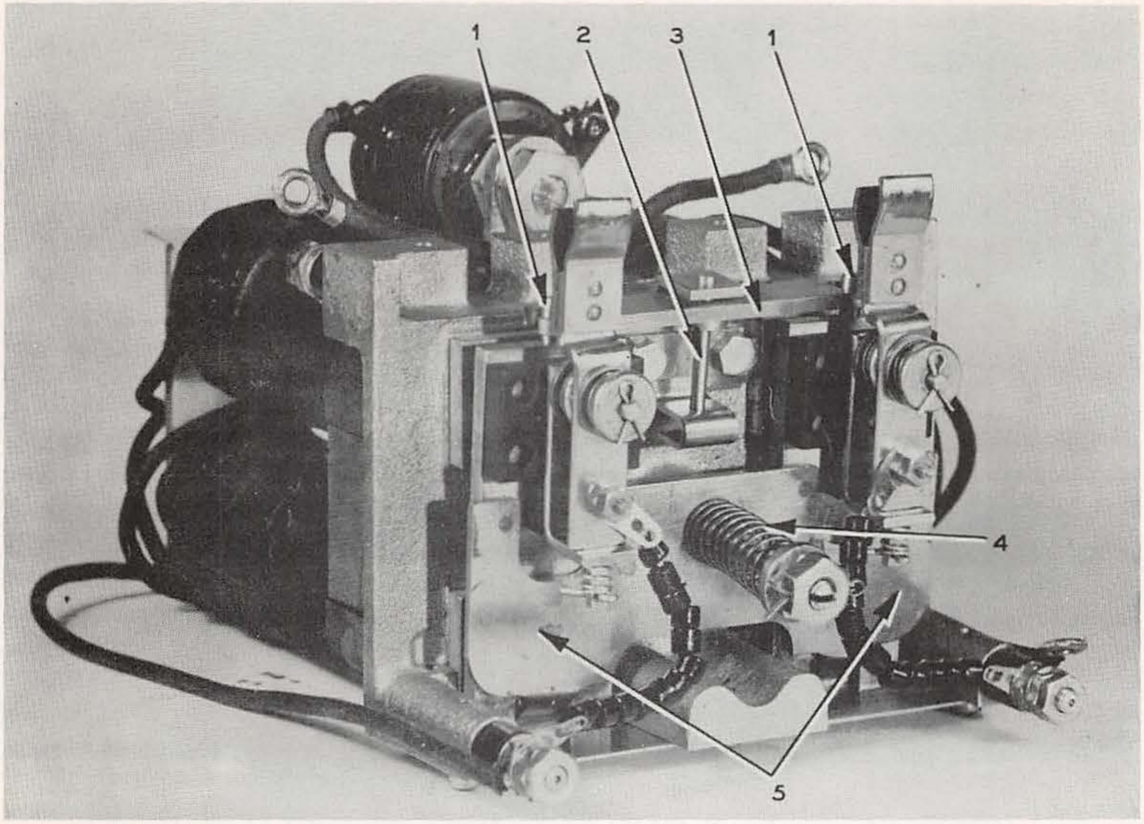


Figure 4. Biased-neutral contactor unit with front and back contact structures removed to show centering device.

Figure 3 shows the construction of this centering device. Barrel shaped pins 1 protrude from the top of each armature. Bar 3 which is fastened to shaft 2 has a slot in each end. These slots engage pins 1. Pressure plate 5 is hinged at the same points as the armatures, and spring 4 keeps pressure plate 5 bearing against the armatures when they are both deenergized. Shaft 2 is so located that the pressure of plate 5 against the deenergized armatures keeps their attached contact fingers midway between the front and back contacts.

When either armature picks up to close its front contact, it moves bar 3 through the medium of pin 1 so that bar 3, in turning with its shaft 2, forces the deenergized armature farther from its pole faces until its back contact is made.

III. RECTIFIER

The blocking rectifier unit mounted on top of the contactor unit, Figures 1 to 4, consists of two sections, one for each contactor. This is a Type B 1/4, half-wave, copper-oxide rectifier with 1-1/2-inch discs. Its electrical function is described on page 10.

IV. OPERATION OF CONTACTORS

The magnetic structure and operation of the biased-neutral contactors are similar to those of Types K and B biased-neutral relays. See G-R-S Development Sheet D56.0201.

Figure 5 is a somewhat simplified drawing of the magnetic structure of one contactor. Figures 6(a), 6(b), and 6(c) are elementary plan views of the magnetic structure of a single contactor showing windings, rectifier, and the directions of the current and the magnetic flux under various conditions.

A biased-neutral contactor is primarily a neutral relay. It is equipped with a permanent magnet between the cores, so arranged that the armature with its associated contact will operate only when current is flowing in one specified direction. Although the rectifier shown in Figure 6 fixes the possible direction of current flow, the magnetic structure is such that the relay will not pick up when voltage of the wrong polarity is applied, even if the rectifier were removed from the circuit.

With the polarity of the magnet as shown in Figure 6(a), and no current flowing through the coils, the flux of the permanent magnet finds a path of low reluctance through the cores and yoke. Hence there is no magnetic attraction to pick up the armature.

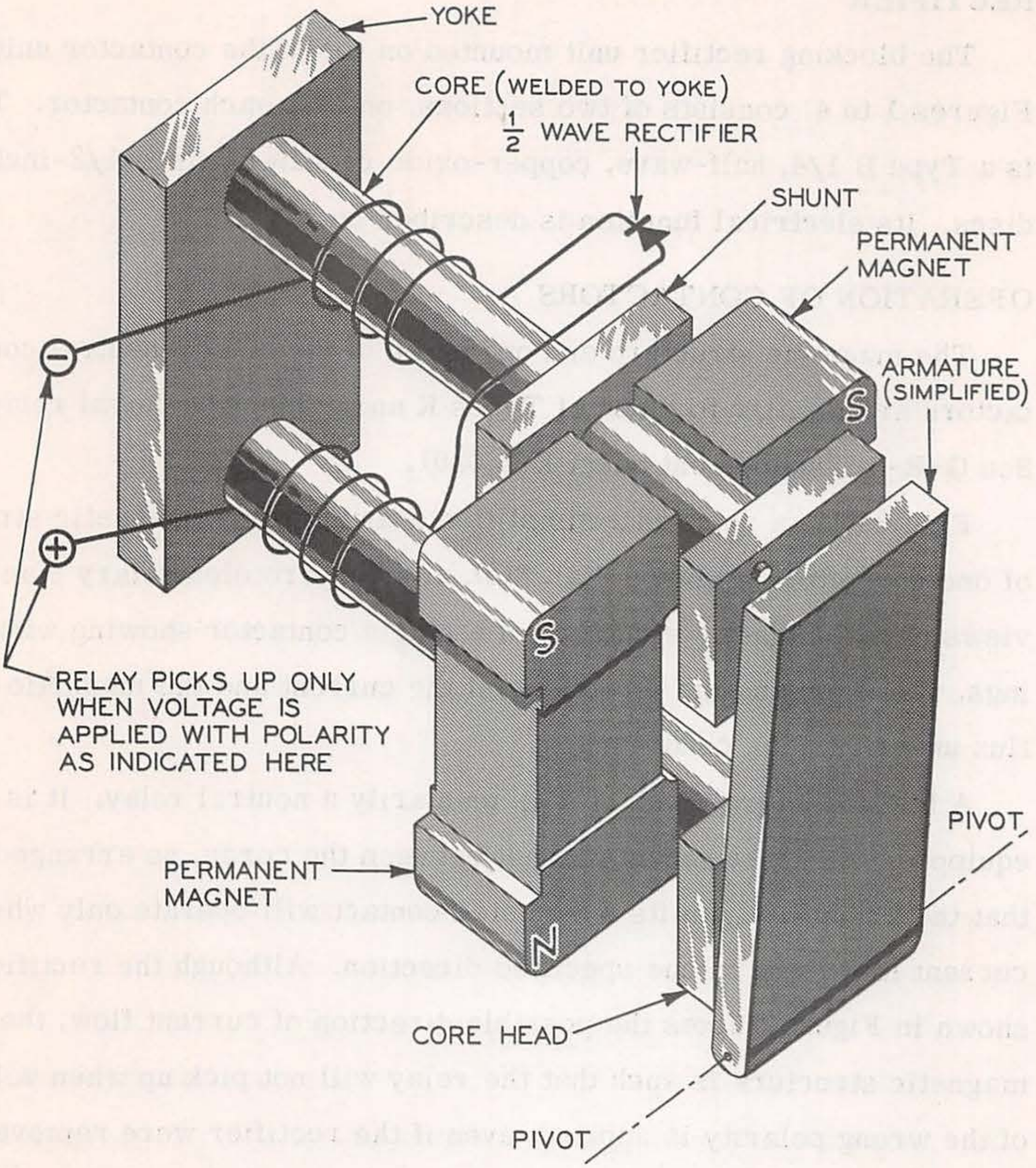

YOKE
CORE (WELDED TO YOKE)
½ WAVE RECTIFIER
SHUNT
PERMANENT MAGNET
ARMATURE (SIMPLIFIED)
S
S
−
+
RELAY PICKS UP ONLY WHEN VOLTAGE IS APPLIED WITH POLARITY AS INDICATED HERE
PIVOT
PERMANENT MAGNET
N
CORE HEAD
PIVOT

Figure 5. Magnetic structure of a biased-neutral contactor.

In Figure 6(b), current is flowing through the coils in such a direction that the magnetomotive force produced opposes that of the permanent magnet. This is the same as creating a high reluctance in the path of the flux from the permanent magnet, and the major part of the flux from the permanent magnet is thus diverted through the armature, along with the flux produced by energization of the coils.

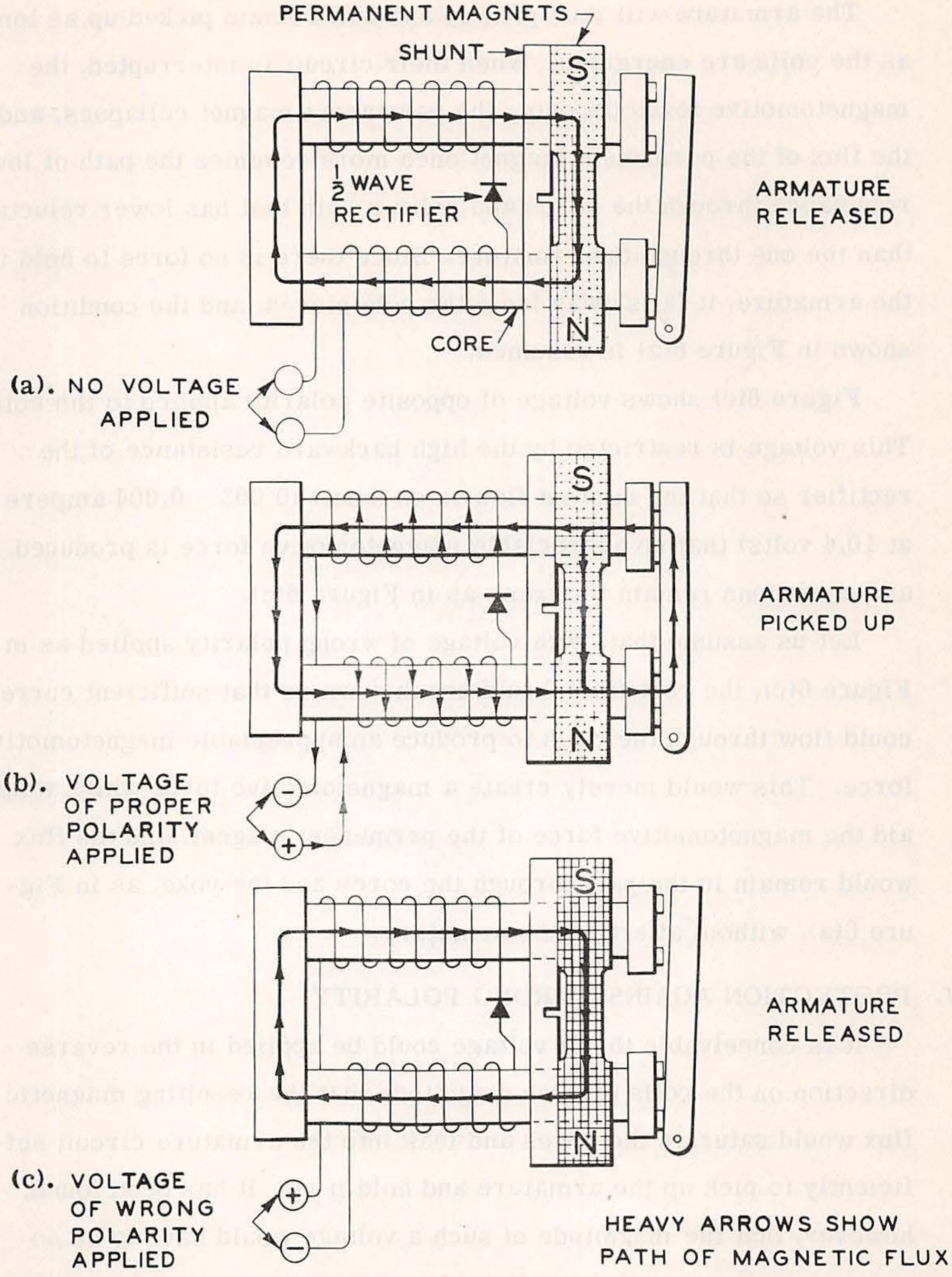

PERMANENT MAGNETS
SHUNT
S
½ WAVE RECTIFIER
ARMATURE RELEASED
N
CORE
(a). NO VOLTAGE APPLIED
S
ARMATURE PICKED UP
N
(b). VOLTAGE OF PROPER POLARITY APPLIED
−
+
S
ARMATURE RELEASED
N
(c). VOLTAGE OF WRONG POLARITY APPLIED
+
−
HEAVY ARROWS SHOW PATH OF MAGNETIC FLUX

Figure 6. Simplified views of a biased-neutral contactor explaining operation.

The armature will thus pick up and will remain picked up as long as the coils are energized. When their circuit is interrupted, the magnetomotive force opposing the permanent magnet collapses, and the flux of the permanent magnet once more resumes the path of low reluctance through the cores and yoke, a path that has lower reluctance than the one through the armature. Since there is no force to hold up the armature, it falls away from the pole pieces, and the condition shown in Figure 6(a) is resumed.

Figure 6(c) shows voltage of opposite polarity applied to the coils. This voltage is restricted by the high backward resistance of the rectifier so that the current flow is so small (0.003 - 0.004 ampere at 10.4 volts) that no appreciable magnetomotive force is produced, and conditions remain the same as in Figure 6(a).

Let us assume that, with voltage of wrong polarity applied as in Figure 6(c), the rectifier should break down so that sufficient current could flow through the coils to produce an appreciable magnetomotive force. This would merely create a magnetomotive force which would aid the magnetomotive force of the permanent magnet, and the flux would remain in the path through the cores and the yoke, as in Figure 6(a), without affecting the armature.

V. PROTECTION AGAINST WRONG POLARITY

It is conceivable that a voltage could be applied in the reverse direction on the coils of such magnitude that the resulting magnetic flux would saturate the cores and leak into the armature circuit sufficiently to pick up the armature and hold it up. It has been found, however, that the magnitude of such a voltage would have to be so great as to far exceed the voltage found in ordinary signal installations.

This voltage has been applied and checked in our laboratory--with the added backleak resistance of the rectifier entirely removed from the circuit--and we have found that the ratio of pickup voltage applied in the proper direction to pickup voltage applied in the wrong direction is about 1 to 400. That is, if 10 volts applied in the proper direction were required to pick up the armature, it would require at least 4000 volts applied in the wrong direction to pick up the armature.

VI. DEAD MAGNET PROTECTION

The alnico magnets used have been knocked down to about 70 percent of their maximum strength. This treatment, together with the naturally high coercive force of this material, insures against loss of magnetism through age.

If it were possible to destroy the permanent magnetism completely, the contactor would operate with energy applied of either polarity. To prevent this, a silicon steel shunt or leakage strip has been placed between the cores as shown in Figures 5 and 6. This shunt is of such a size that, even with the mass of the magnet removed, it will effectively by-pass all of the coil flux, thus preventing the armature from picking up with either polarity applied. Normally, the permanent magnet flux permeates the shunt so that it becomes, in effect, part of the magnetic mass.

VII.FUNCTION OF THE RECTIFIER

As shown in Figures 5 and 6, a rectifier is connected between the coils of each contactor. Connecting the rectifier between the coils instead of in series with an end lead of either coil provides some measure of protection against the effects of lightning, since lightning discharges are of high frequency and would thus tend to be choked out by the reactance of the coils.

The rectifier is used for the following reasons:

1. It permits a relatively high energy input to the contactor. As soon as the motor-control contacts within the switch machine have operated in response to the energization of the control circuit, the energy input to the contactor is cut down to the amount permitted by the back leak of the rectifier (0.003 - 0.004 ampere at 10.4 volts). This makes normally energized control practical and economical--although not essential to operation of controller.
2. Both contactors are in multiple when the switch machine is unlocked, but only one is taking current. The only current through the other contactor is that permitted by the back leak of the rectifier. This permits the use of control wires with higher resistance than is practicable with present controllers.
3. Since only one contactor is energized when the machine is unlocked, and since both contactors are connected in multiple, there is a tendency for the deenergized contactor to absorb the inductive surge produced by the other contactor when the control energy is interrupted in midstroke.

VIII.CONSTRUCTION OF OVERLOAD RELAY

The overload relay, Figure 7, is constructed on a Type B basis, the cores, copper slug and washers, and armature mounting being the same as used in Type B relays. Three 5/16-24 cap screws one inch long are used to fasten it to the terminal board, and it can be removed in a unit as shown in Figure 7.

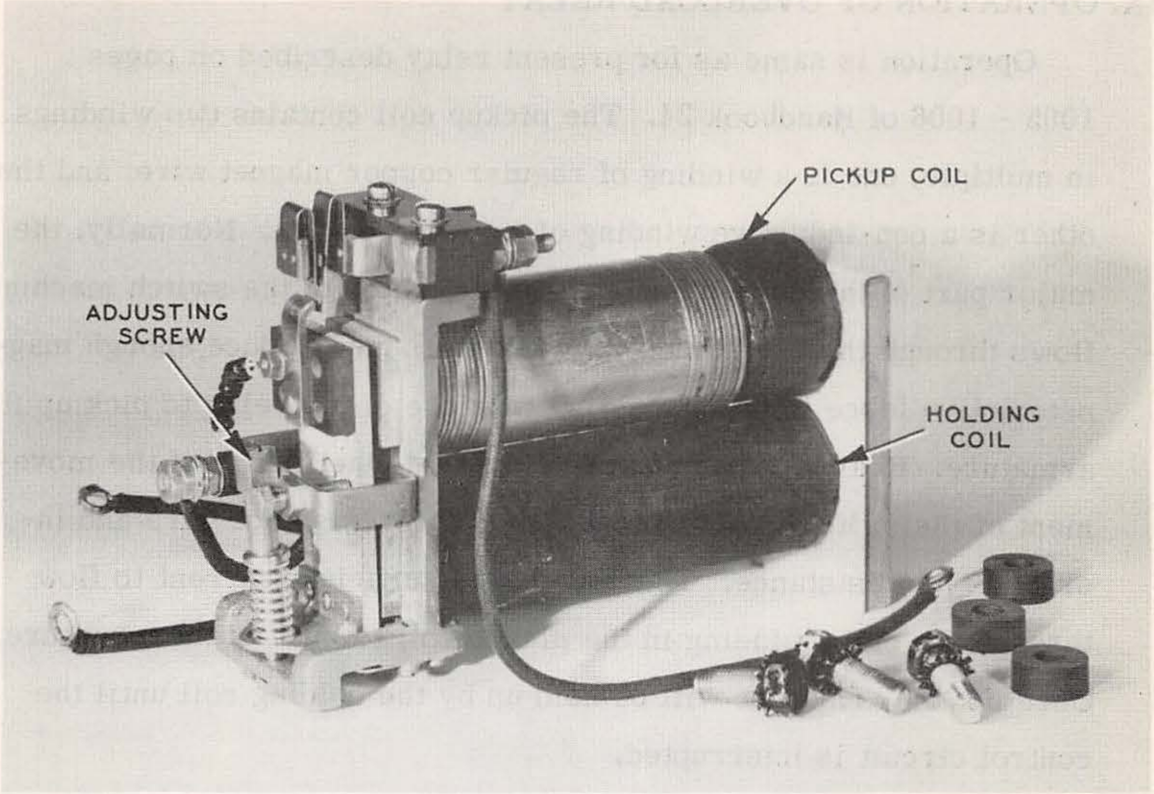


Figure 7. Overload relay.

The electrical and magnetic principles employed are the same as in the present overload relay. There is one pickup coil and one holding coil. A copper slug and washers make the relay slow-acting. The pickup time is adjusted by the slotted-head screw which may be seen just in front of the armature. This screw is readily accessible when the relay is in the controller case. Present pickup time is 4 seconds at 10 amperes.

The holding coil occupies the entire core and is so constructed that an external series resistance such as is used in the present relay is not required.

There is one dependent, front-back contact of the make-before-break type. Contact material is silver.

IX. OPERATION OF OVERLOAD RELAY

Operation is same as for present relay described on pages 1005 - 1006 of Handbook 24. The pickup coil contains two windings in multiple, one is a winding of regular copper magnet wire, and the other is a non-inductive winding of resistance wire. Normally, the major part of the current to operate the motor of the switch machine flows through the resistance wire and does not produce enough magnetomotive force in the magnetic structure of the relay to pick up its armature. Heavy current, such as the motor will draw if the movement of the switch is obstructed, heats the resistance wire and increases its resistance. This will cause sufficient current to flow through the other winding in the pickup coil to pick up the armature, Once up, the armature will be held up by the holding coil until the control circuit is interrupted.

The action of the relay is retarded by the copper slug and washers so that it will not pick up in response to the momentary surges of current that occur when starting or reversing the motor.

When the overload relay picks up, it removes energy from both contactors. See Figure 9, page 15.

X. CONSTRUCTION OF CONTROLLER CASE

The case is made of cast aluminum, the same as the present case. It has only one terminal board, instead of the present 2, and no insulation is required in the bottom of the case. All holes through the walls of the case have been eliminated.

As shown in Figure 8, the terminal board, with all units attached can be removed from the case by taking out 4 screws which are tapped into the case.

Self-Resetting Dragging Equipment Detector

In the October 1946 G-R-S NEWS, page 40, mention is made of a dragging equipment detector. Since that time we have had inquiries for more information on this device.

The G-R-S self-resetting dragging equipment detector, Figure 1, does not have any parts that are broken when it is used. The detector resets itself after dragging equipment hits it.

This detector does not need new parts every time it is tripped. Besides this saving in parts, there is a saving in maintenance time. It is possible, of course, that the detector could be struck with such great force that it would need repairs. A train with this kind of dragging equipment would probably never get very far anyway after the equipment first tore loose.

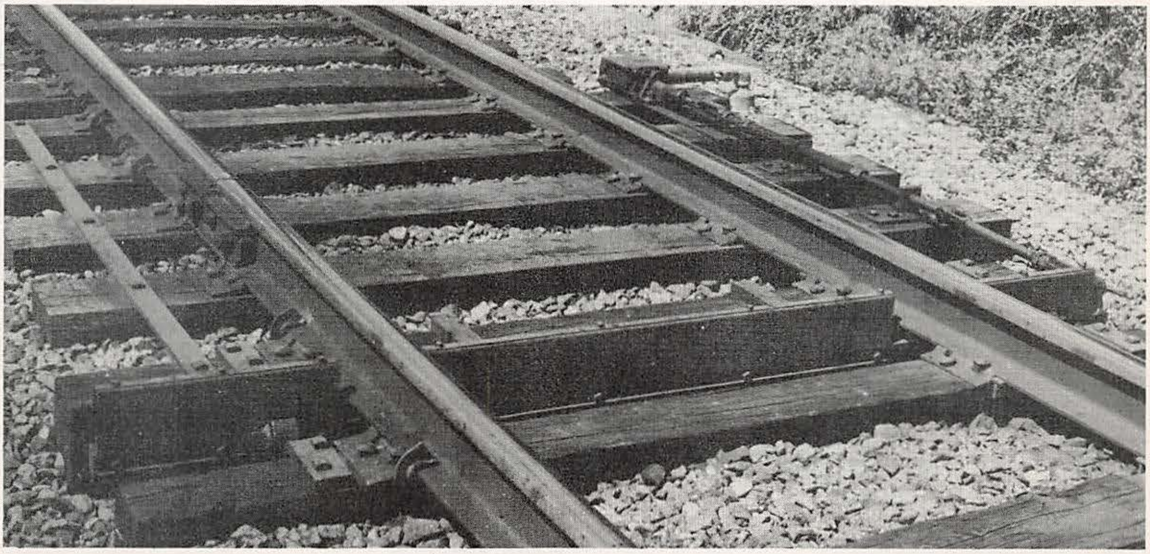


Figure 1. G-R-S self-resetting dragging equipment detector.

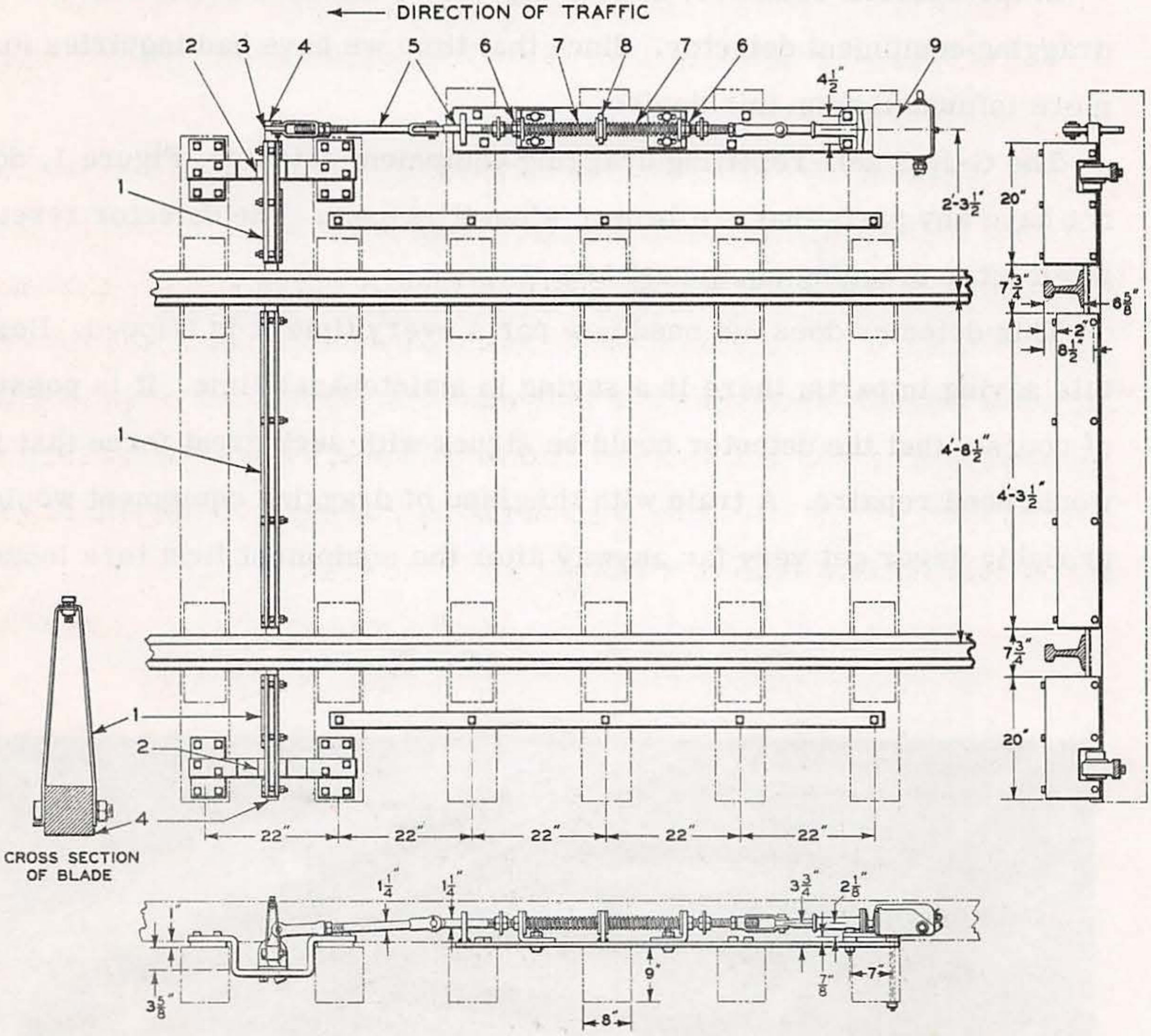

DIRECTION OF TRAFFIC
1
2
3
4
5
6
7
8
9
4½"
2'-3½"
20"
7¾"
6⅝"
2"
8½"
4'-8½"
4'-3½"
22"
CROSS SECTION OF BLADE
1¼"
3¾"
2⅛"
9"
⅞"
7"
3⅝"
8"

Figure 2. Typical layout of G-R-S self-resetting dragging equipment detector.

DESCRIPTION

Figure 2 shows various views of the detector as it is installed on the track. A 2-inch square iron shaft, reference 4, is mounted between the ties on two cast-iron journals, reference 2. Journals 2 have a 3-5/32-inch bore, with bearing surfaces 2-1/4 inches long. A 1/4-inch oil hole is in the top of each journal bracket. These oil holes are easy to get at when oiling the detector.

Three blades, reference 1, are fastened to shaft 4 with 1/2-inch bolts. Nuts are held tight with lock washers. If you will look at the cross section sketch of one of the blades shown in Figure 2, you will see that each blade is made of two pieces of sheet steel lapped together at the top and fastened with 3/8-inch bolts and lock washers. This sheet steel is 0.104 inch thick. The nuts are fillet welded to the underside of the bottom lap so it is easy to take the blade sections apart and put them together again if you ever have to replace a blade.

Crank arm 3 is welded to shaft 4. Jointed rods 5 connect crank arm 3 to the plunger of circuit controller 9. The joints on rods 5 are clevis joints with 7/8-inch pins held in place by 3/16- by 1-1/2-inch cotters. These joints should be oiled regularly, as well as the circuit controller plunger and other sliding surfaces on the linkage between the circuit controller and the crank arm.

Springs 7 push against bracket 8 and nuts and washers 6. Springs 7, acting through rods 5 and shaft 4, keep the blades upright and return them to an upright position after they have been struck by dragging equipment.

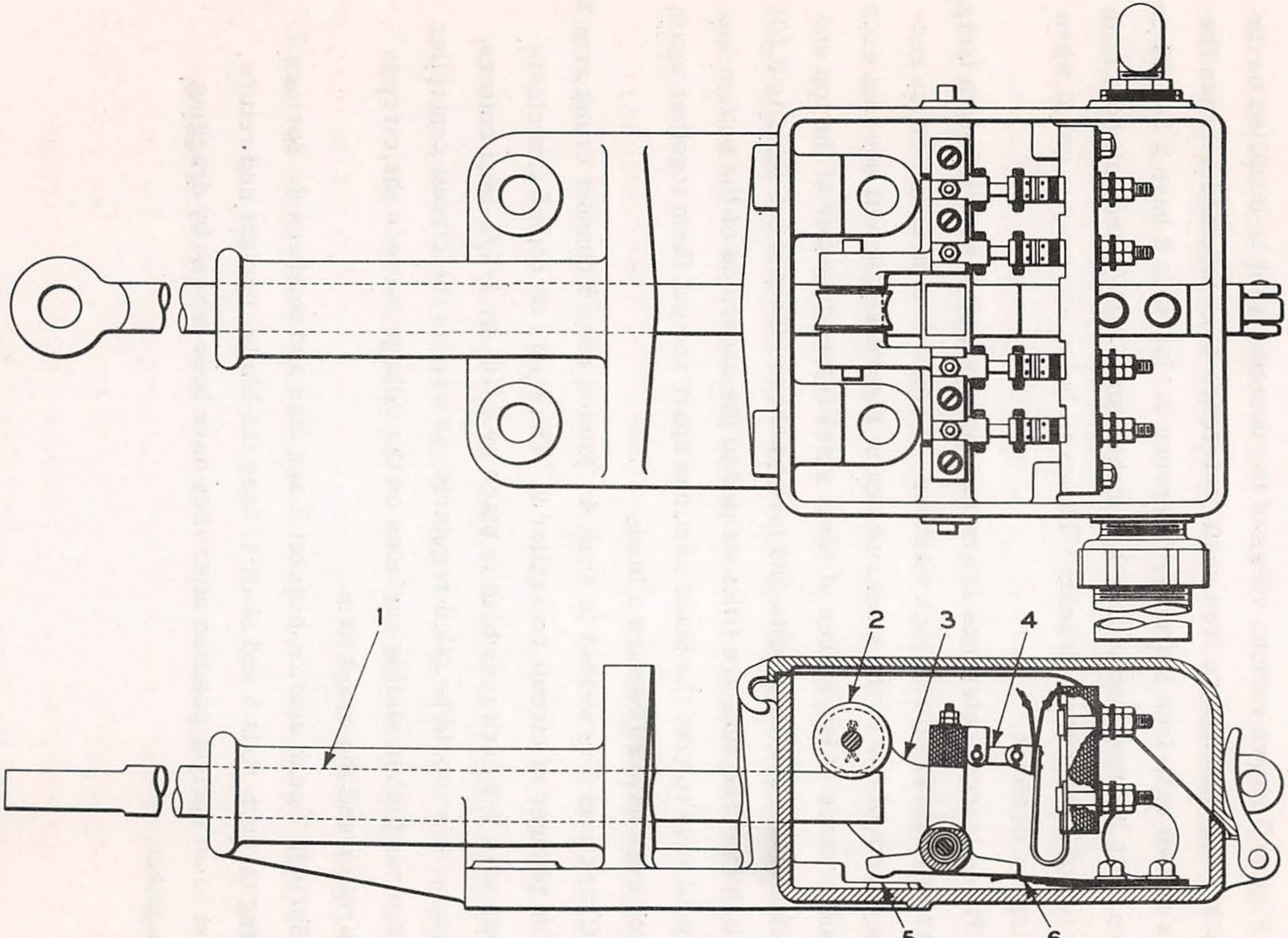


Figure 3. Top and side views of circuit controller used with self-resetting dragging equipment detector.

Figure 3 shows the circuit controller in more detail. The cast-iron case is 3/8 inch thick. There are four mounting holes for 3/4-inch bolts. The cover is gasketed and fitted with a hasp. Two 1-1/4-inch pipe threaded holes in the case, one on either side, are for the ventilator and the wiring inlet. A 1-1/2-inch to 1-1/4-inch reducing fitting and a 1-1/2-inch pipe nipple 2-1/2 inches long are furnished for attaching 1-1/2-inch rubber conduit.

There are four normally closed silver-to-silver independent contacts. You may notice that the drawing shows a back contact on each contact finger. These back contacts are simply parts of the standard contact fingers. They are not used in this application of the circuit controller. Binding posts are standard A.A.R. number 14-24. You can get at the contacts, binding posts, and other inside parts very easily when the cover is off.

Any parts that could rust or corrode are protected by painting or plating.

HOW THE DETECTOR WORKS

When a train with dragging equipment passes over the detector, the dragging parts will hit one or more of the three blades, reference 1, in Figure 2. The blades are moved with the blow and turn shaft 4. Shaft 4 turns attached crank arm 3. Crank arm 3 moves rods 5 and the plunger of circuit controller 9 in the direction of traffic (shown by an arrow in Figure 2).

To see what happens inside the circuit controller when the plunger is moved, let us now look at Figure 3. Plunger 1 moves to the left, out from under roller 2. Springs 6 now force operating arm 3 to turn on its shaft until it comes up against stop 5. Operating arm 3 moves linkages 4. Linkages 4 move the contacts to their open positions.

You will notice that there is an arrow showing the direction of traffic in Figure 2. If the traffic is in the other direction, install the detector the same as shown in Figure 2, but connect rod 5 to the lower end of crank arm 4.

HOW A TYPICAL CIRCUIT WORKS

Figure 4 is a circuit showing one way to hook up this detector at the entrance to an interlocking plant. Relay DED in the tower is normally fed by a multiple circuit through 1T front and the normally closed contacts of the dragging equipment detector. Unless there is a train on 1T, you cannot drop relay DED by pushing the detector blades. This circuiting keeps the pranksters from putting signal 2 to stop. If track circuit 1T is fairly short, no one will care to stand on the track kicking the detector blades when a train is coming.

When a train with dragging equipment moves toward signal 2 on track 1T, track relay 1T will be down. As soon as the dragging parts hit the blades, the detector contacts open. Current is cut off from relay DED, and it opens its front contacts and closes its back contacts. Current is cut off from relay DEDP, and it opens its front contacts, thus putting signal 2 to stop.

The buzzer and the indication lamp in the tower are fed current through the back contact of DED. Thus notified of the condition, the towerman informs the engineer. After the towerman has told the engineer, he simply presses the reset pushbutton to again set up the stick circuit through relay DED. The system returns to normal, as the detector contacts closed again right after the dragging equipment opened them.

FOR OPERATION IN EITHER DIRECTION

You can use this detector just as effectively where you have trains in both directions on the same track. Instead of the controller in Figure 3, use your regular switch circuit controller - whatever is standard for your railroad. Adjust it so all contacts are normally closed. Have half the contacts open when the detector blades swing one way, and have the other contacts open when the blades swing the other way.

You can use the same circuit idea as Figure 4. Just duplicate everything from the heel of 1T on so you can get control of the opposing signal through its associated detector contacts.

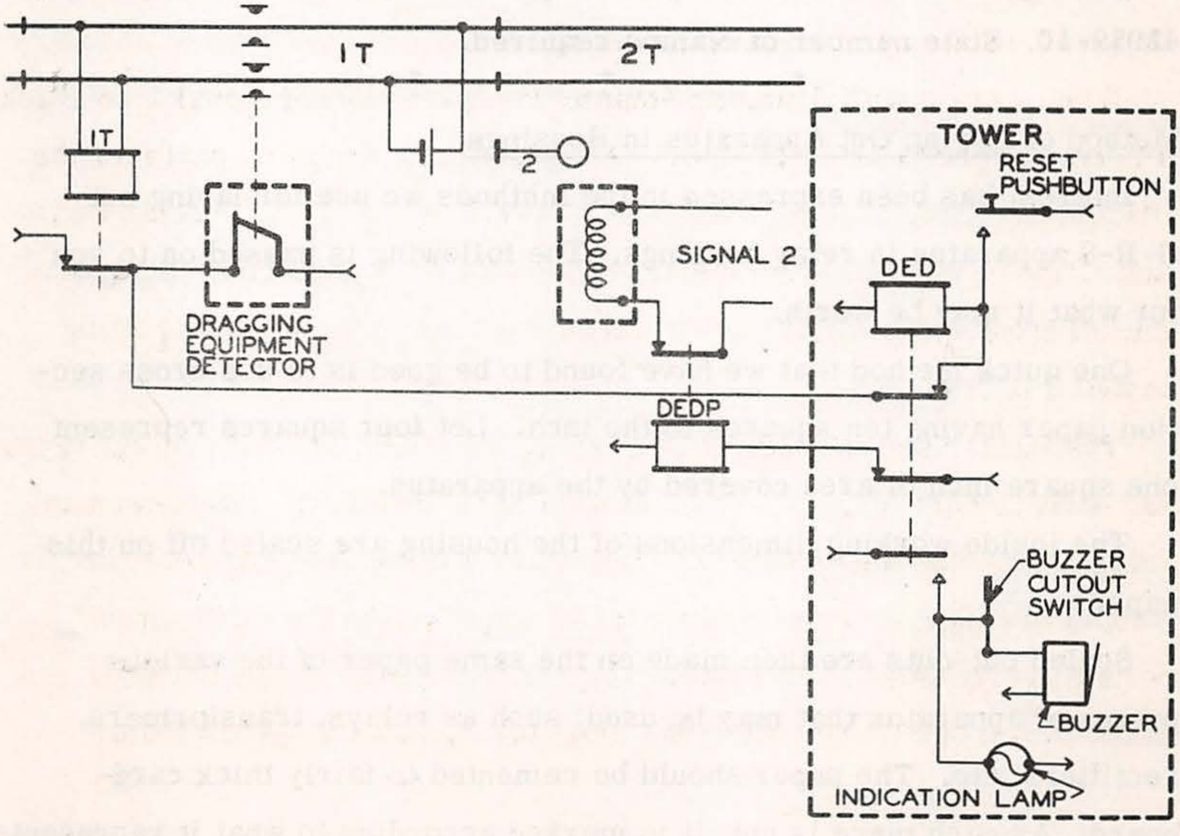

1T
2T
1T
2
DRAGGING
EQUIPMENT
DETECTOR
SIGNAL 2
TOWER
RESET
PUSHBUTTON
DED
DEDP
BUZZER
CUTOUT
SWITCH
BUZZER
INDICATION LAMP

Figure 4. Simplified circuit for dragging equipment detector.

INSTALLATION

Figure 2 shows all there is to the installation. You don't have to frame any ties, and only two holes in the ties are needed, for the through-bolts holding down the circuit controller. All the tie straps, plates, etc. are shipped to you ready drilled, so the parts are easy to line up to fasten to the ties.

ORDERING INFORMATION

To order a G-R-S self-resetting dragging equipment detector complete with all necessary plates, tie straps, lag screws, bolts, etc. as shown in Figure 2, specify number 58451-2. To order 5-ply rubber conduit to fit the wiring inlet nipple, order number 52313-9 and specify length required. Galvanized hose clamps to fit this conduit are number 43959-10. State number of clamps required.

* * *

Method of Laying Out Apparatus in Housings

Interest has been expressed in the methods we use for laying out G-R-S apparatus in relay housings. The following is passed on to you for what it may be worth.

One quick method that we have found to be good is to use cross section paper having ten squares to the inch. Let four squares represent one square inch of area covered by the apparatus.

The inside working dimensions of the housing are scaled off on this paper.

Scaled cut-outs are then made on the same paper of the various pieces of apparatus that may be used, such as relays, transformers, rectifiers, etc. The paper should be cemented to fairly thick cardboard. As each piece is cut, it is marked according to what it represents.

The pieces are then laid on the housing plan with sufficient space for wiring, tagging, etc.

* * *

Roy Connell Dies

Roy C. Connell, retired sales engineer from our New York office, died October 5 at the home of his sister, Mrs. L. R. Slawson, in Jonesville, Michigan. He was buried in Westfield, New Jersey.

Roy was born September 29, 1876 at Traer, Iowa. He was educated in the public schools of Chicago and began his career as machinist apprentice in 1892 with E. B. Preston and Co. in Chicago. He entered railway service in 1894 as signal helper on the Chicago and Northwestern. This experience led to the position of fitter with the National Switch and Signal Co. in 1898. In 1900 he became foreman on automatic signaling and interlocking construction with the Chicago and Northwestern, the Hall Switch and Signal Co. and the Taylor Signal Co., which in 1904, through consolidation with the Pneumatic Signal Co., became the General Railway Signal Co. From 1908 to 1910 he worked with the Federal Signal Co. in the development of its electric interlocking. In 1910 he joined the Hall Switch and Signal Co. and did similar work. Later he became designing engineer of electric interlocking apparatus, principal assistant engineer, and chief of the inspection bureau. His duties also included sales and service engineering. On August 1, 1919, he became inspector on special work with the New York Municipal Railway. In June, 1920, he accepted the position of sales engineer with the General Railway Signal Co. at New York, which position he held until his retirement on October 1, 1946.

* * *

Ed Addis, George Hagenbach in Hospital

Ed Addis went to Highland Hospital October 23, with ulcer hemorrhage. He's had two blood transfusions and is feeling better.

George Hagenbach came to work as usual on October 2. That morning he felt ill, went to the Medical Center, then to Strong Memorial Hospital by ambulance. A blood clot in the arteries of the heart (coronary thrombosis) is the diagnosis. We learn George will be in the hospital about six weeks.

* * *

Bob Parks Retires

Robert H. Parks, assistant superintendent, has retired after 20 years with the company.

Bob was born at St. Charles, Mo., July 19, 1870. He went to St. Charles College in that city, studying manufacturing, and in 1896 was employed as general manager by the Merchants Dispatch Transportation Corporation at East Rochester, N. Y. In 1913 he was employed as general manager of the Bettendorf Company at Bettendorf, Iowa, and in 1917 as vice-president and general manager of the Canadian Car and Foundry Company of Canada. From 1920 to 1925 he was president of the Buffalo Steel Car Company at Buffalo, N. Y. and in November, 1927, came with us as executive in the sheet metal department being formed at that time. In June, 1931 he was appointed assistant superintendent.

G-R-S NEWS
December 1947

Magnetic-Stick Relays

New magnetic-stick relays in the Type B and K lines are now being made.

The mag-stick relay that most of us know is the Type A used on centralized traffic control jobs for storing indications. It is fitting, therefore, that we start with a review of the principles of the Type A relay as a basis for the Types B and K relays described later.

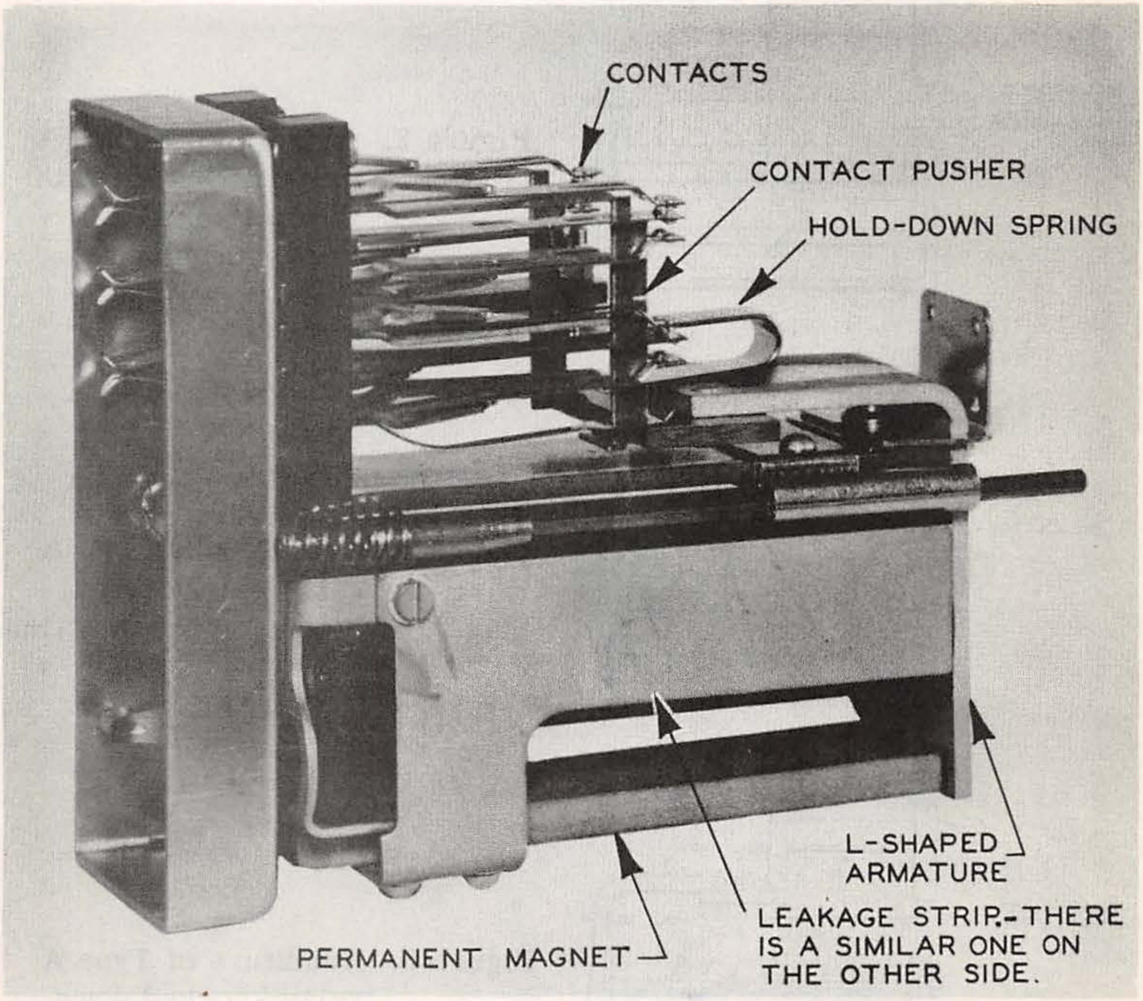

CONTACTS
CONTACT PUSHER
HOLD-DOWN SPRING
L-SHAPED ARMATURE
LEAKAGE STRIP.-THERE IS A SIMILAR ONE ON THE OTHER SIDE.
PERMANENT MAGNET

Figure 1. Type A magnetic-stick relay for cTc.

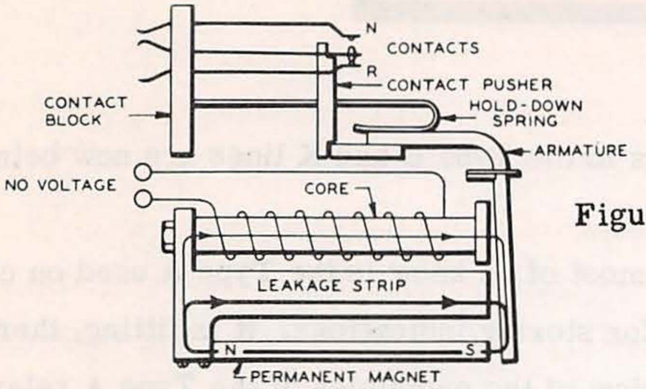

N
CONTACTS
R
CONTACT PUSHER
CONTACT BLOCK
HOLD-DOWN SPRING
ARMATURE
NO VOLTAGE
CORE
LEAKAGE STRIP
N
S
PERMANENT MAGNET

Figure 2. Type A magnetic-stick relay in the reverse position, with the armature held down by the spring.

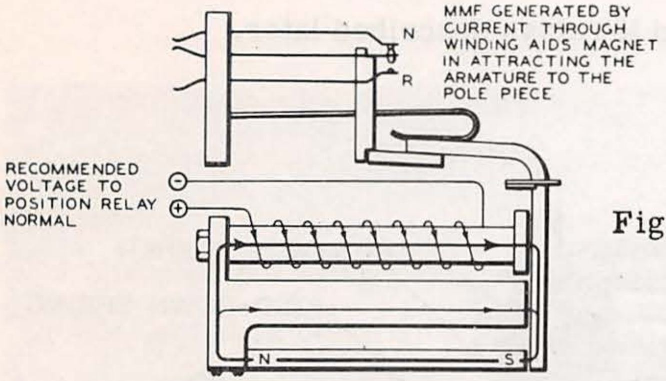

MMF GENERATED BY CURRENT THROUGH WINDING AIDS MAGNET IN ATTRACTING THE ARMATURE TO THE POLE PIECE
N
R
RECOMMENDED VOLTAGE TO POSITION RELAY NORMAL
⊖
⊕
N
S

Figure 3. Armature of Type A relay picked up with normal polarity across winding.

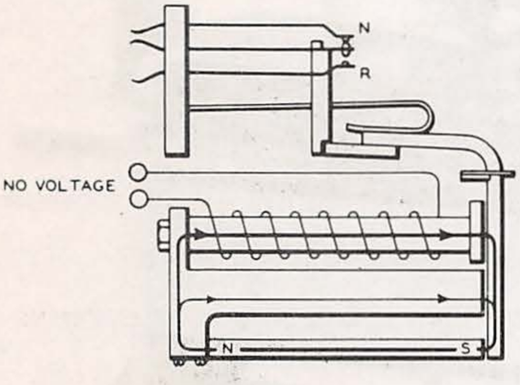

N
R
NO VOLTAGE
N
S

Figure 4. Armature of Type A relay stuck normal by magnetic attraction.

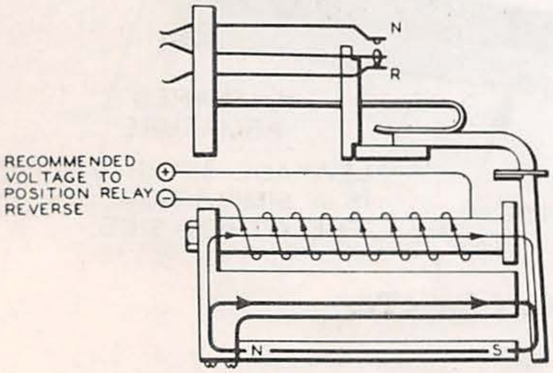

N
R
RECOMMENDED VOLTAGE TO POSITION RELAY REVERSE
⊕
⊖
N
S

Figure 5. Armature of Type A relay knocked down with reverse polarity across windings.

I. PRINCIPLES OF TYPE A MAGNETIC-STICK RELAYS

Figure 1 shows the main parts of the Type A mag-stick relay. It is so familiar to most of us that we'll not spend time describing the relay in detail.

Figure 2 shows how the flux of the permanent magnet is distributed through the leakage strip and the core when the armature is released. You will see that most of the flux finds its way through the strip because it offers the lowest reluctance. Some flux passes through the core, but the magnetic force is so small it fails to pull the armature up to the pole face against the pressure of the hold-down spring.

Let us now apply a voltage across the coil of such polarity that the current through the coil will tend to lower the reluctance of the core, as in Figure 3. We thus divert more flux through the core and less through the strip. More flux in the core pulls the armature and so closes the N contact.

Once we have closed the armature air gap the magnet alone has the strength to keep the armature tight against the pole piece. So Figure 4 shows how we can deenergize the coil and let the magnet do the work. This saves energy, especially when the armature must be held in one position for a long time.

When you want to knock down the armature, you pass current through the coil in the opposite direction, as shown in Figure 5. You don't have to hold the energy on very long - just long enough to build up a high reluctance in the core. This weakens the flux and allows the hold-down spring to push the armature away from the pole face. Contact R closes. The flux distributes itself the way it was in Figure 2. The armature stays down until you pass current through the coil again as in Figure 3.

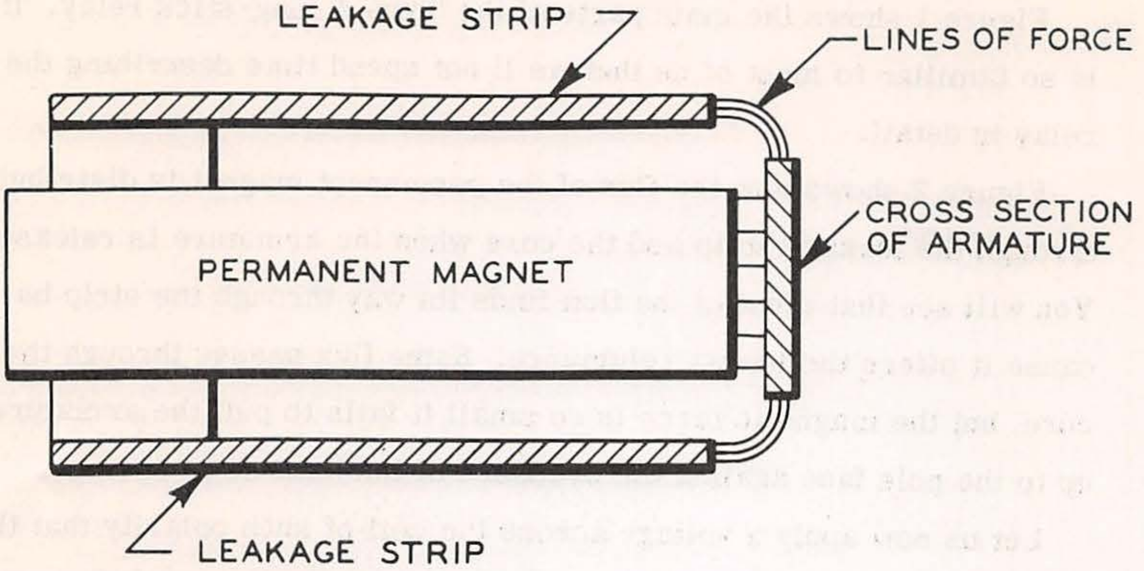


Figure 6. Top view showing how the magnet, strips and armature are related. The tendency for the flux is to crowd on the edges of the armature where the pulling effect is practically nil.

You have probably been wondering why the heavy flux from the magnet, through the armature, and through the leakage strips does not pick up the armature. You'll find the answer in Figure 6. Note how the strips are set off to the sides of the armature (you are looking down on the relay). Any pulling effect is therefore sideways. The strips cannot exert a direct pull on the armature. Moreover, because the gap between the magnet and the armature is so great, the pull there is too small to be of any use.

We have used the Type A relay only in so-called "non-vital" circuits - circuits on which we do not depend for safety. Such circuits are the switch, signal and track indication circuits shown in our cTc handbooks.

II. TYPE B MAGNETIC-STICK RELAYS

A. How They are Built

The Type B magnetic-stick relays look much like standard Type B neutral relays. You will see, however, in Figure 7, two main points where they differ:

1. There are two permanent magnets clamped to the cores (you can see only one in the photo).
2. The coil leads are soldered to terminals which lie in the number two contact space, between the two vertical rows of contacts.

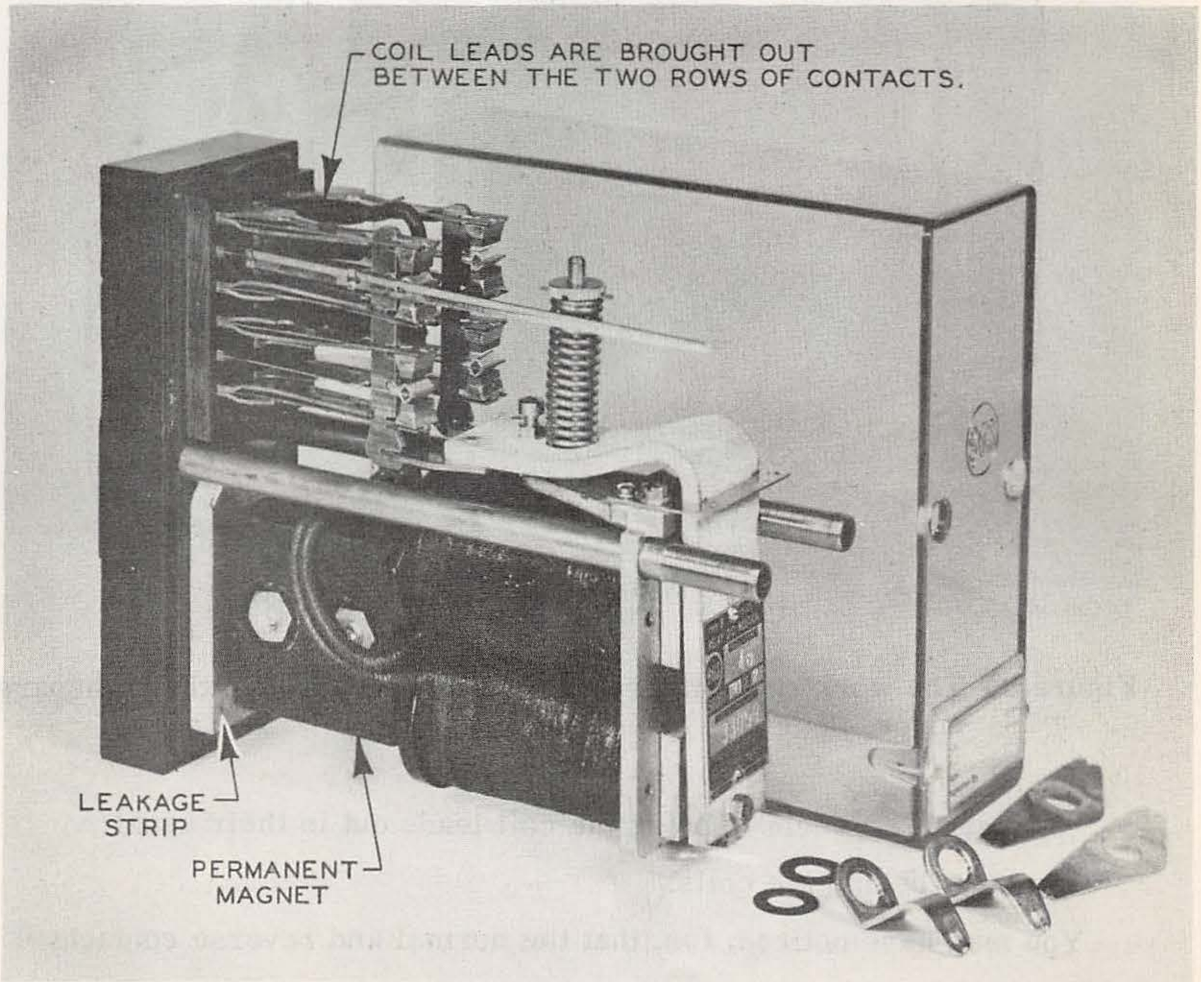

COIL LEADS ARE BROUGHT OUT BETWEEN THE TWO ROWS OF CONTACTS.
LEAKAGE STRIP
PERMANENT MAGNET

Figure 7. Type B magnetic-stick relay.

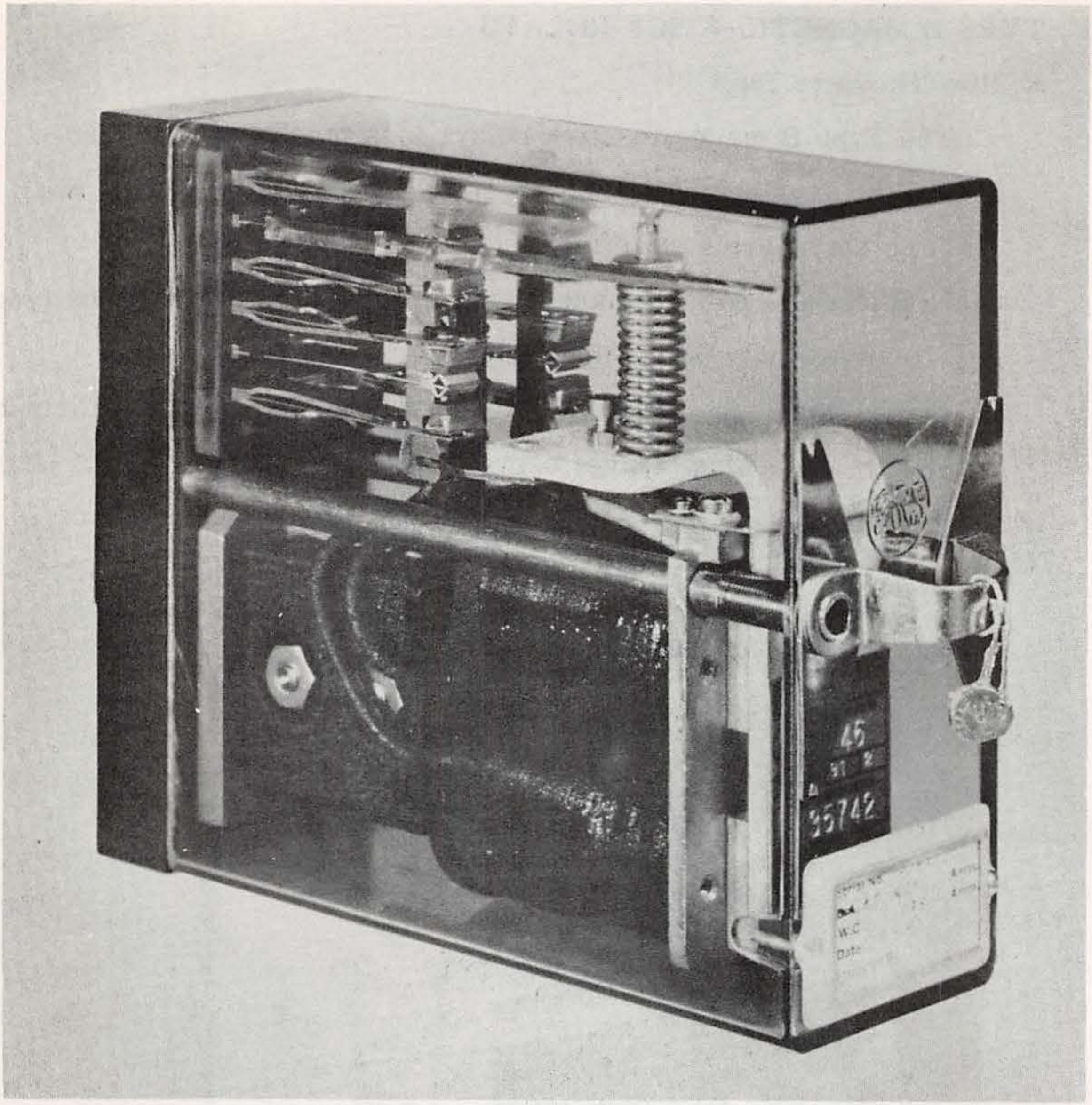


Figure 8. The working parts are easy to inspect through the transparent cover.

There's no room to bring the coil leads out in their usual place, behind the coils.

You may have noticed, too, that the normal and reverse contacts are silver-impregnated carbon against silver. The relays are built with 4NR dependent contacts only.

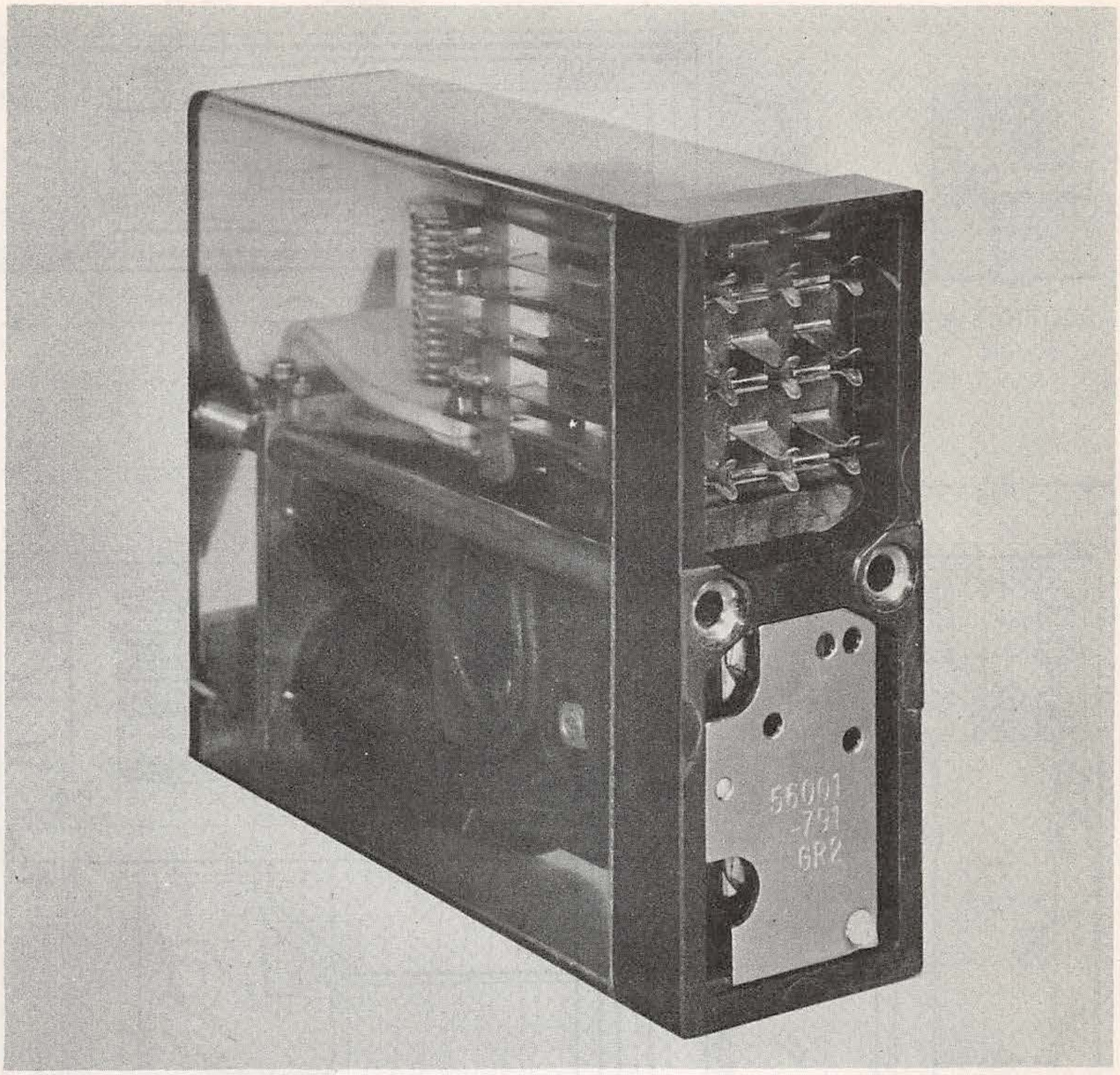


Figure 9. You cannot plug this relay in the wrong place. The registration plate must match up with a similar plate on the plugboard.

The working parts are protected by a clear plastic cover, Figure 8. To prevent you from plugging the relay into the wrong place, we have provided a registration plate in the back of the relay, Figure 9. This plate matches up with a similar plate with plugs, which is in the plugboard (not shown). Unless the two do match, the relay terminals cannot engage the plugboard terminals, and you cannot complete the circuits.

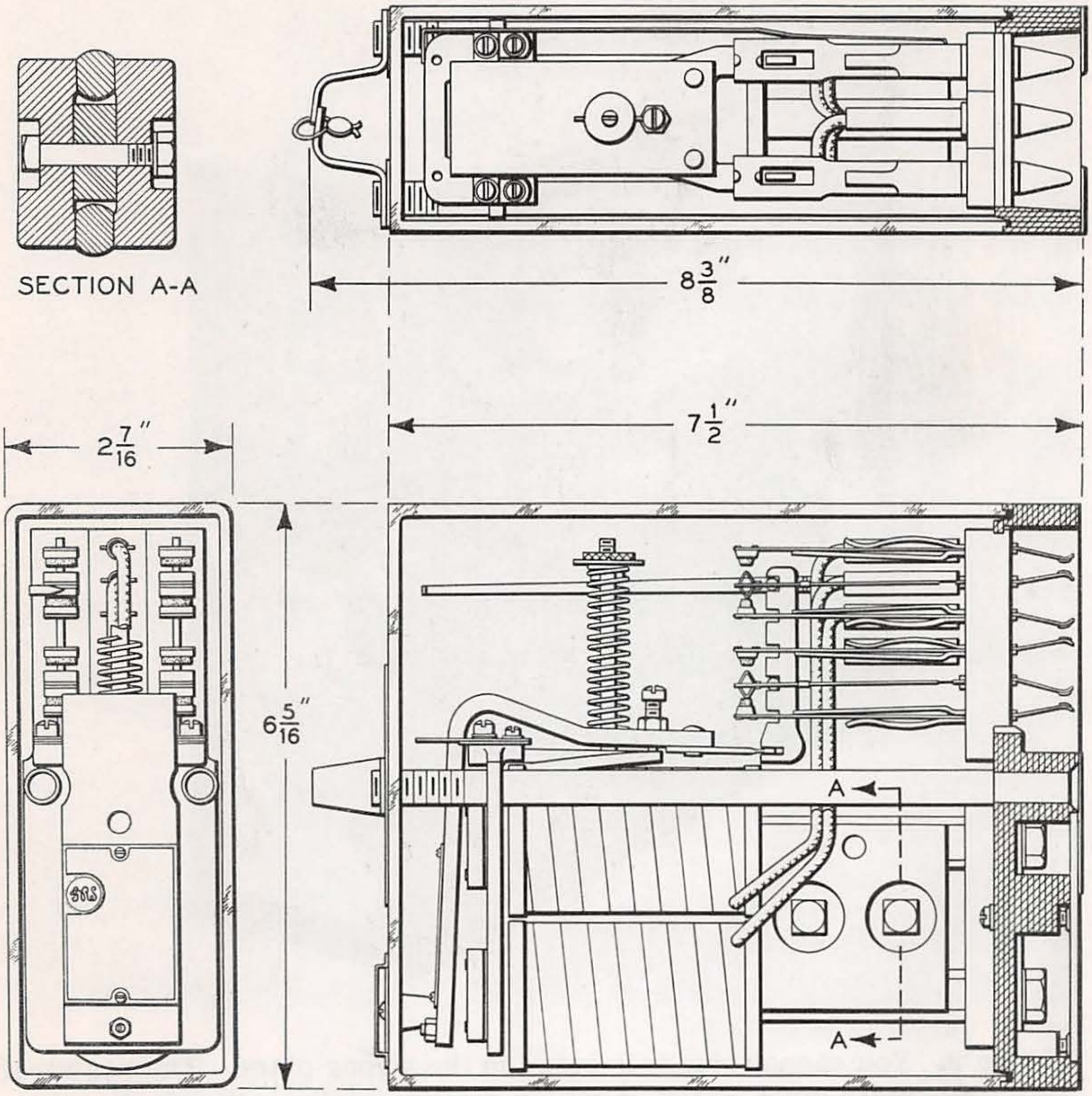

SECTION A-A
$8\frac{3}{8}''$
$7\frac{1}{2}''$
$2\frac{7}{16}''$
$6\frac{5}{16}''$
A
A
GRS

Figure 10. Type B Size 1 magnetic-stick relay.

Figure 10 gives the overall dimensions and construction details.

B. How They Work

Like the A relays, the B relays work on the simple principle of shifting the permanent magnet's flux from leakage strip to cores and vice versa.

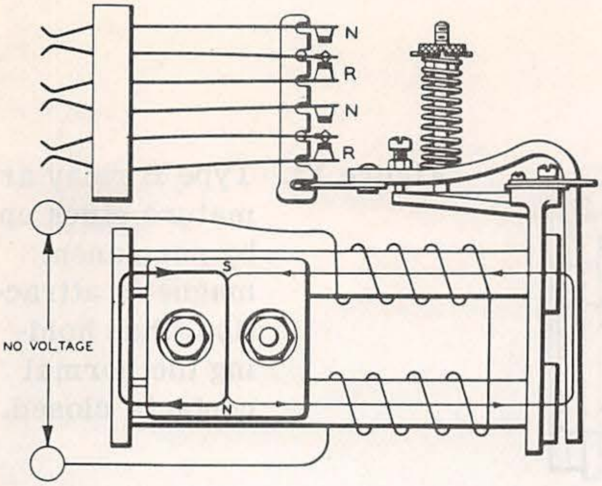


Figure 11. Type B magnetic-stick relay in the reverse position.

In Figure 11, most of the magnet flux finds a path through the leakage strip. Since very little flux crosses the air gap into the armature, it is held away from the pole faces by the coil spring. The reverse (R) contacts are closed. No current is flowing in the coils.

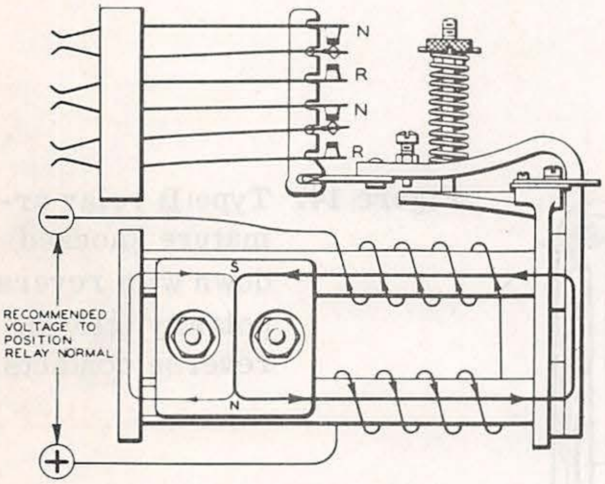


Figure 12. Type B relay armature picked up with normal polarity, closing normal contacts.

To pick up the armature and close the normal (N) contacts, we apply voltage of the polarity shown in Figure 12. The current through the coils reduces the reluctance of the path through the armature. Hence more flux follows this path. The magnetic force increases at the pole faces and pulls the armature up. There is little flux now through the leakage strip because its reluctance is higher than that of the path through the armature.

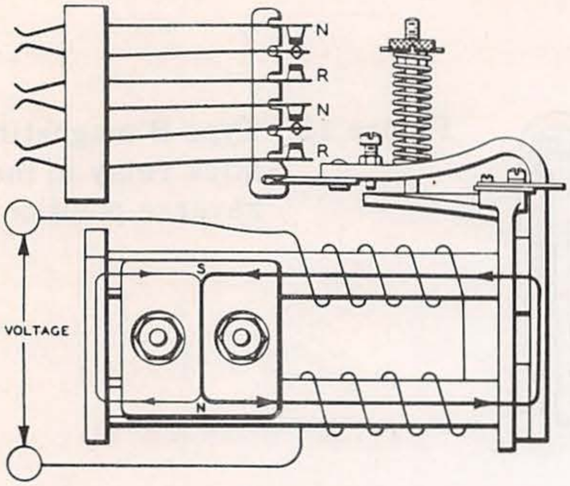


Figure 13. Type B relay armature stuck up by permanent magnet's attraction, thus holding the normal contacts closed.

It takes less force to hold the armature up than it does to pick it up. Current can be cut off the coils and the magnet will "stick" the armature. Hence the term "magnetic-stick relay". This is the condition in Figure 13.

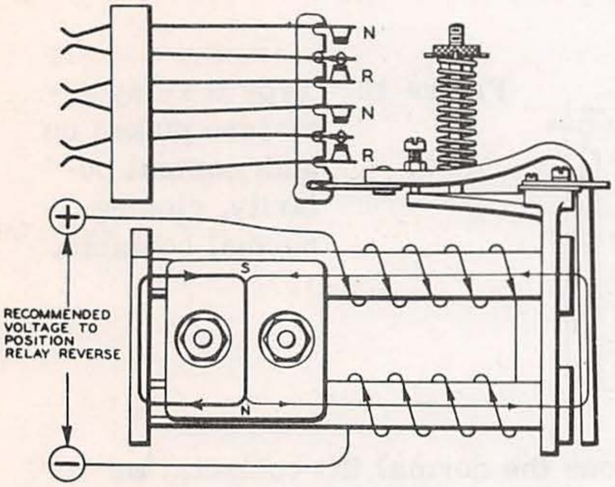


Figure 14. Type B relay armature knocked down with reverse polarity, closing reverse contacts.

To knock the armature down, you merely send a current in the reverse direction through the coils. This increases the reluctance of the path through the armature. The flux through the armature is cut back and the spring overcomes the magnetic pull. The armature goes down, the reverse contacts make, and most of the flux once more goes through the leakage strip as in Figure 14.

C. Resistances and Operating Values

Up to now we have furnished the B mag-stick in three sizes of resistances. The table below gives the corresponding operating values for each relay:

Ordering Ref.	Resistance	Max. PU Amp.	Max. Knockdown Amp.	PU Normal with Reverse Current
56001-791 Gr. 1	30	0.035	0.035	0.280 A. min.
56001-791 Gr. 2	46	0.028	0.028	0.224 A. min.
56001-791 Gr. 3	1100	0.006	0.006	0.048 A. min.

These values are shop values and may change.

We try to keep the pickup and knockdown values equal in order to get balanced normal and reverse currents in the circuits.

The last column on the right needs some explanation. After knocking down the armature you can put too much current through the coils and pick up the armature again. We have checked these values and have found they have to be about 8 times the normal amount of current that you'd need to knock down the armature. You should watch out for this in the circuit design and application.

Ask for test specifications by giving the relay ordering reference number stamped on the nameplate on the armature.

D. Internal Wiring

Internal wiring is shown in Figure 15. The relay picks up — that is, the normal contacts 13, 16, 33, and 36 close — with + on 24 and - on 26. On the plugboard you have to connect a jumper between terminals 23 and 25 to complete the coil circuit.

You can identify the OUT lead as the one leaving the end of the coil nearer the armature.

The magnets are assembled with the north pole (marked N) towards the bottom of the relay. You can check the north end of the magnet with a compass. It should attract the end of the compass which normally points to geographic South.

A spacer slightly thicker than the cores is placed between the magnets so that when you draw the bolts tight, you don't run the risk of cracking the magnets.

If the magnets are assembled with the north end up, + on 24 and - on 26 will reverse the relay. If the north end of one magnet is assembled adjacent to the south end of the other on the cores, the relay will act like a regular neutral relay. There will be no mag-stick action.

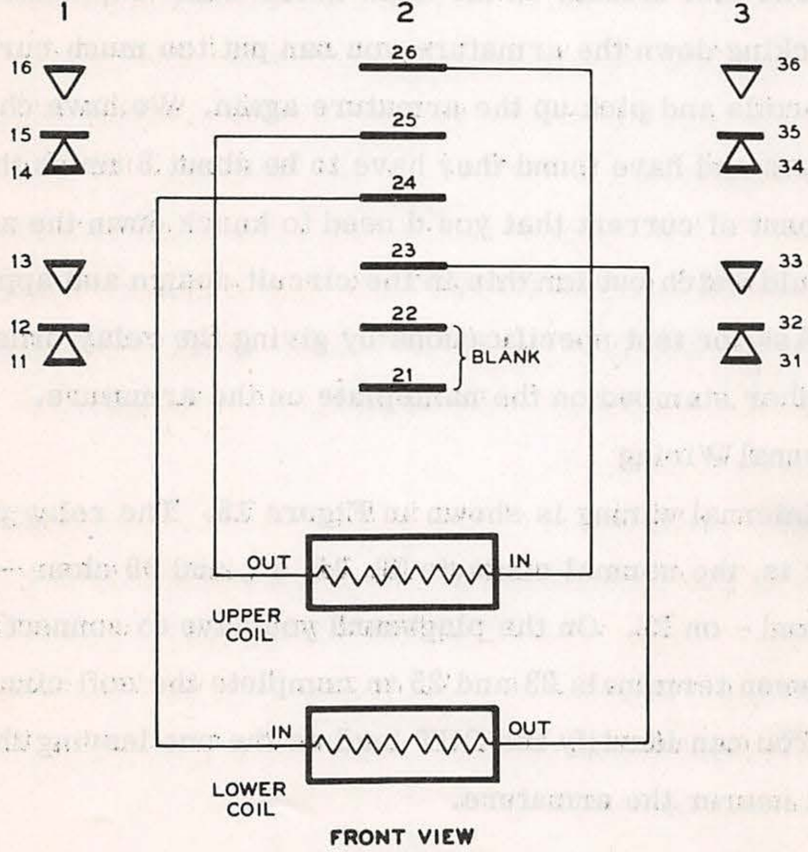

1
2
3
16
26
36
15
25
35
14
24
34
13
23
33
12
22
32
11
21
31
BLANK
OUT
IN
UPPER COIL
IN
OUT
LOWER COIL
FRONT VIEW

Figure 15. Internal wiring of the Type B mag-stick relay.

III.TYPE K MAGNETIC-STICK RELAYS

A. How They are Built

You can see from Figures 16 and 17 that the Type K mag-stick is our Type K flasher with two changes:

1. the coil shunting contacts are removed, and
2. a permanent magnet is in the place of the core which carries the copper slugs on the flasher.

The K mag-stick has 4 dependent NR contacts, platinum-silver to platinum-silver. Like other K relays, it can be shelf- or wall-mounted. Height is 8-7/8 inches, width 7-3/8 inches, depth 6-1/4 inches. Add 5/8 inch to height for the springs when shelf-mounted.

Figure 18 shows how the armature is pivoted on two bearings. The bearings are part of the center core. The permanent magnet fits into a cup-shaped adapter at its lower end. At its upper end the magnet is necked and fits into another adapter which bolts to the yoke straps.

The reason for necking the magnet is to prevent its being assembled up-side down. The north end is thus always at the bottom.

The armature is slightly V-shaped on its top surface so that it can rock from pole piece to pole piece. It carries the contacts on insulated contact blocks.

Armature stops are adjustable metal studs striking fiber plates riveted to the ends of the armature. They stand out plainly in the rear view, Figure 17.

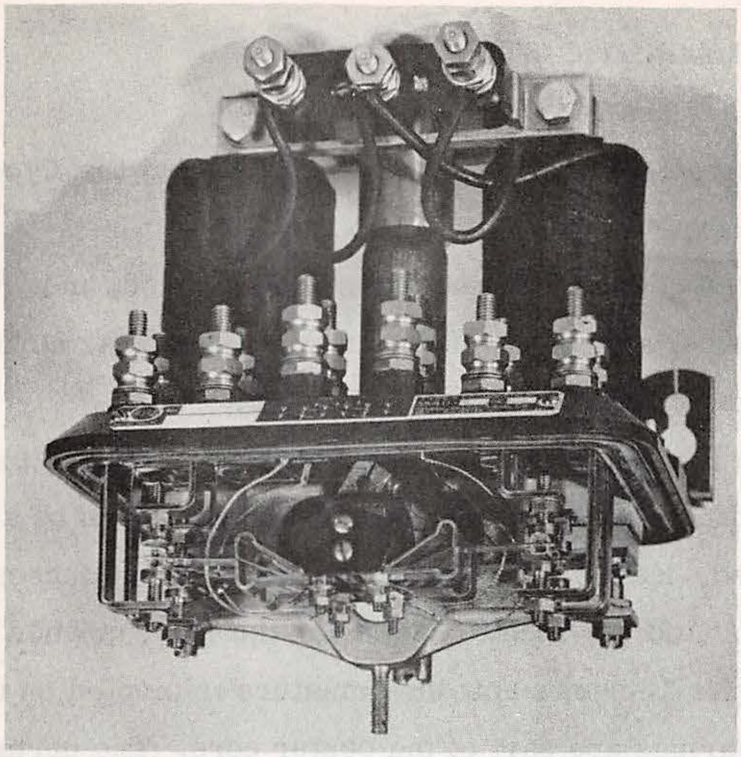


Figure 16. Type K mag-stick relay, cover removed, front view.

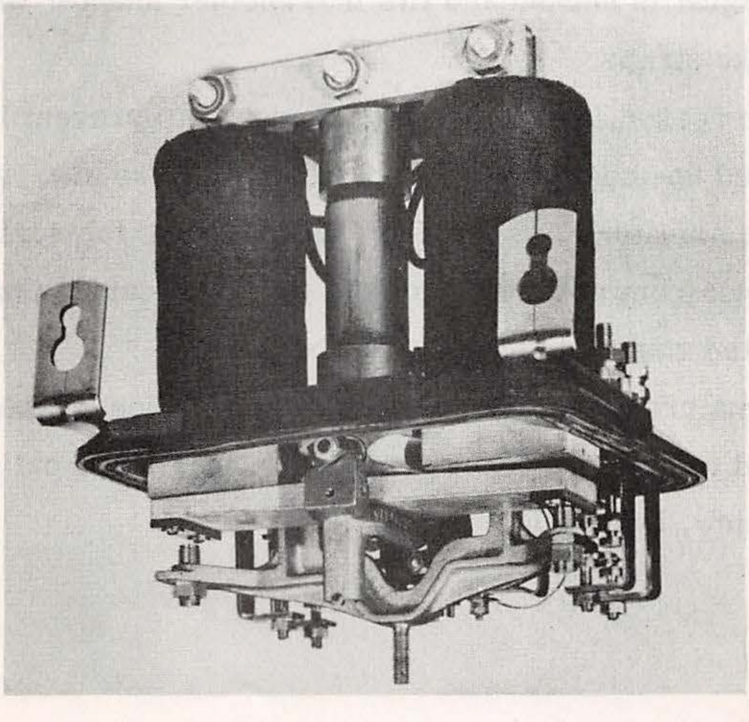


Figure 17. Type K mag-stick relay, cover removed, rear view.

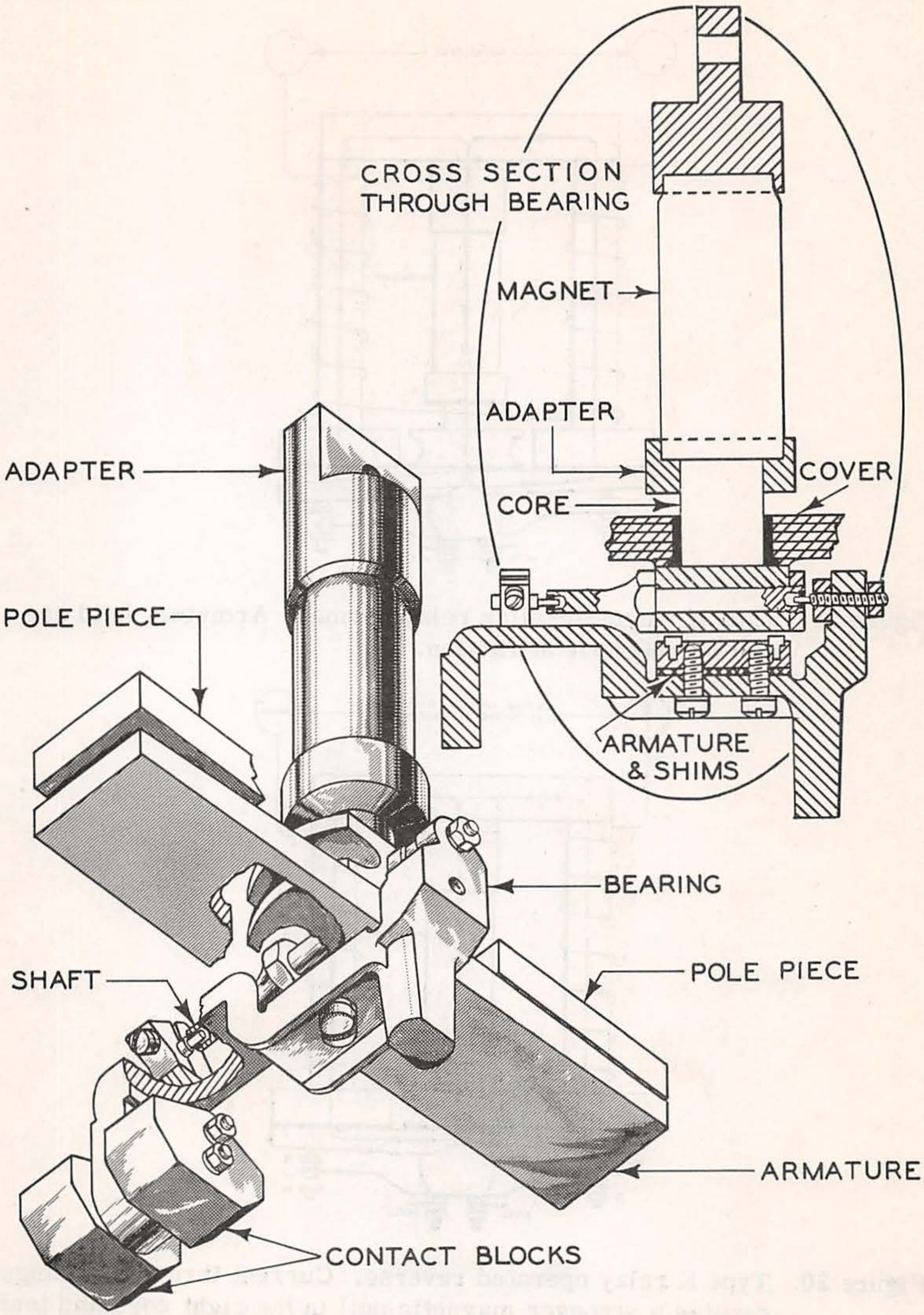

CROSS SECTION
THROUGH BEARING
MAGNET
ADAPTER
COVER
CORE
ARMATURE
& SHIMS
ADAPTER
POLE PIECE
BEARING
SHAFT
POLE PIECE
ARMATURE
CONTACT BLOCKS

Figure 18. How the armature is pivoted in the Type K mag-stick.

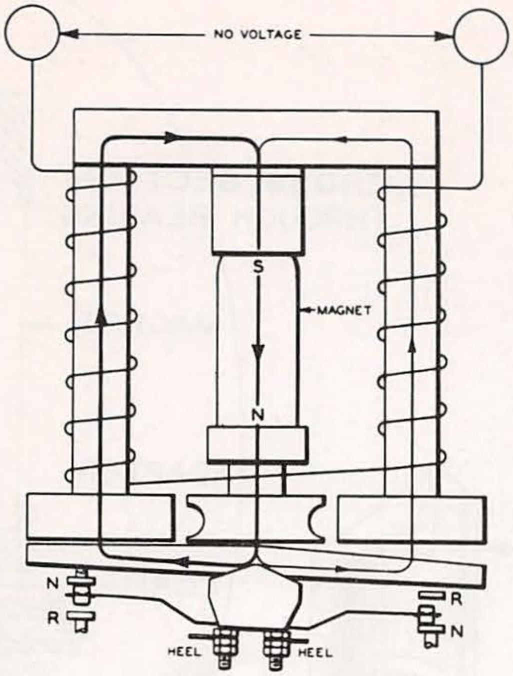

NO VOLTAGE
S
MAGNET
N
N
R
R
N
HEEL
HEEL

Figure 19. Type K magnetic-stick relay normal. Armature held normal by magnetic attraction.

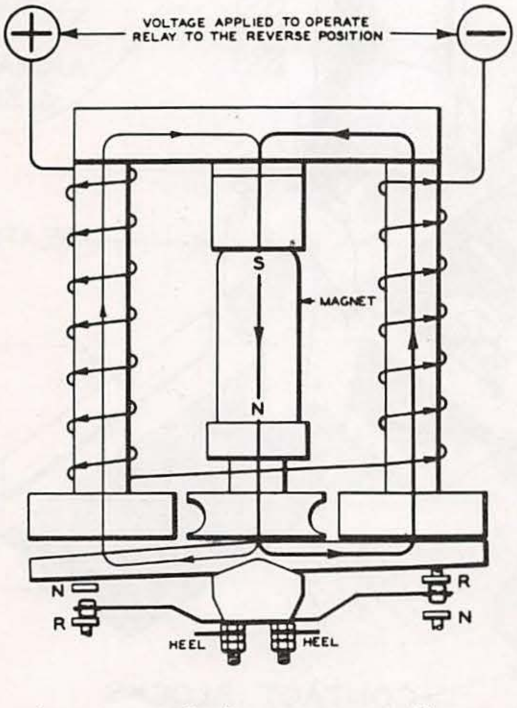

VOLTAGE APPLIED TO OPERATE RELAY TO THE REVERSE POSITION
S
MAGNET
N
N
R
R
N
HEEL
HEEL

Figure 20. Type K relay operated reverse. Current through windings creates a stronger magnetic pull in the right core and tends to cancel any pull that exists in the left core.

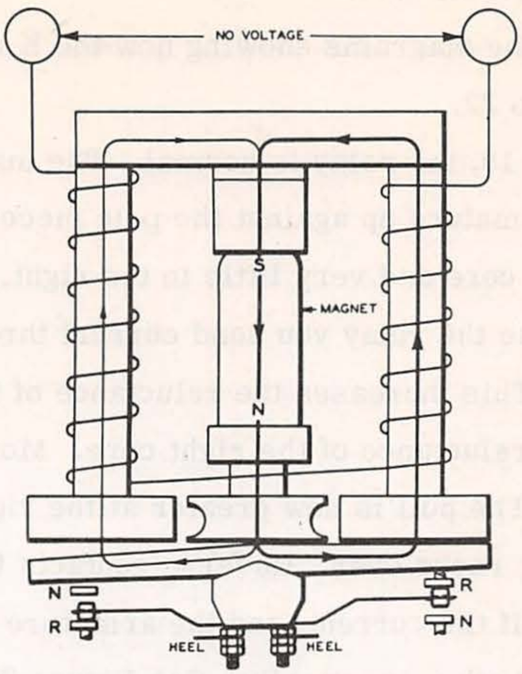

NO VOLTAGE
S
MAGNET
N
N
R
HEEL
HEEL
R
N

Figure 21. Type K relay stuck reverse by magnetic attraction.

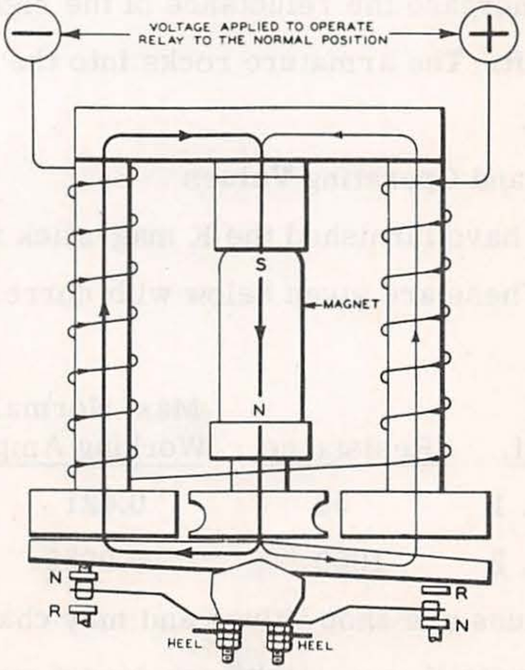

−
VOLTAGE APPLIED TO OPERATE RELAY TO THE NORMAL POSITION
+
S
MAGNET
N
N
R
HEEL
HEEL
R
N

Figure 22. Type K relay operated normal. Current through windings creates a stronger magnetic pull in the left core and tends to cancel any pull that exists in the right core.

B. How K Mag-Sticks Work

Refer to the diagrams showing how the K mag-stick works, Figures 19 to 22.

In Figure 19, the relay is normal. The magnet holds the left end of the armature up against the pole piece. Most of the flux is in the left core and very little in the right.

To reverse the relay you send current through the coils as in Figure 20. This increases the reluctance of the left core and decreases the reluctance of the right core. More flux shifts into the right core. The pull is now greater at the right pole piece, and the armature rocks over. Reverse contacts (R) close.

Now cut off the current, and the armature stays in the reverse position — stuck magnetically. See Figure 21.

To drive the relay normal, you send current through the coils in a way to increase the reluctance of the right core and lower that of the left. The armature rocks into the normal position as in Figure 22.

C. Resistances and Operating Values

So far we have furnished the K mag-stick in two sizes of resistances. These are given below with corresponding operating values:

Ordering Ref.	Resistance	Max. Normal Working Amp.	Max. Reverse Working Amp.
53411-50 Gr. 1	50	0.021	0.021
53411-50 Gr. 2	1000	0.0055	0.0055

These values are shop values and may change.

Note that with K mag-sticks you cannot make the armature go normal by putting too much reverse voltage across the coils. This merely pulls the armature harder against the reverse pole face.

The K magnetic structure is better than the B's in this respect.

Ask for test specifications by relay reference number stamped on the nameplate on the cover.

D. Wiring

Detailed wiring is shown in Figure 23. The relay makes its normal contacts with + on the right-hand terminal post and - on the left. The coils are connected in series normally.

You can identify the OUT lead of a coil as the one nearer the tag that is taped into the coil.

E. Ordering

When ordering state if K relays are to be mounted on walls or shelves. Give us the battery voltage and a sketch of the circuit. This will save much time and writing.

IV.HOW MAG-STICK RELAYS ARE USED

If you refer to G-R-S Development Sheet D01.5301 on G-R-S Unit-Wire Circuits, you'll find two typical examples of how these relays are used. On page 5, Figure 1, the CWZR relay is a mag-stick connected in series with another mag-stick (WZR) in the field. The purpose of these relays is described on the same page.

On page 12, Figure 3, the WKR relay is a mag-stick. Its function is given on page 13 of the same development sheet.

Let us know if you need extra copies of this development sheet.

Remember that all our mag-stick relays are communication relays only.

V. A FEW FACTS ABOUT OUR PERMANENT MAGNETS

We use alnico magnets in our magnetic-stick relays. Alnico is a metallic alloy of aluminum, nickel, cobalt, and iron. It possesses high energy values per unit of weight — about 25 times as great as the old type carbon steel magnets.

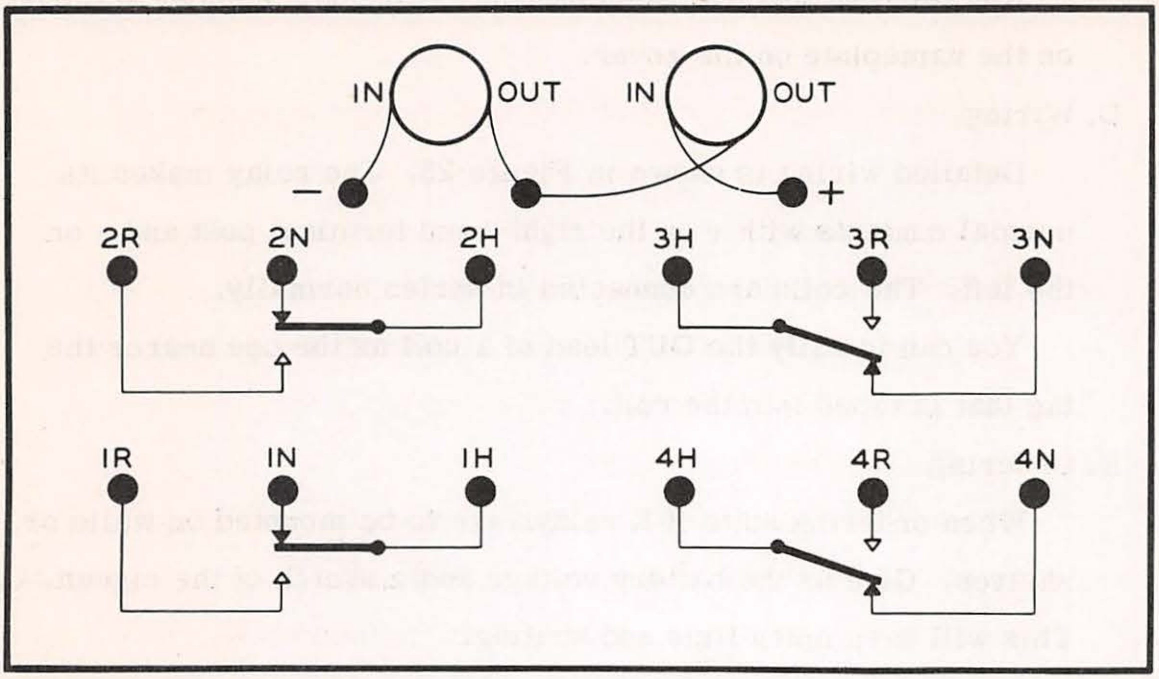

IN
OUT
IN
OUT
−
+
2R
2N
2H
3H
3R
3N
IR
IN
IH
4H
4R
4N
TOP VIEW

Figure 23. Wiring of Type K mag-stick relay.

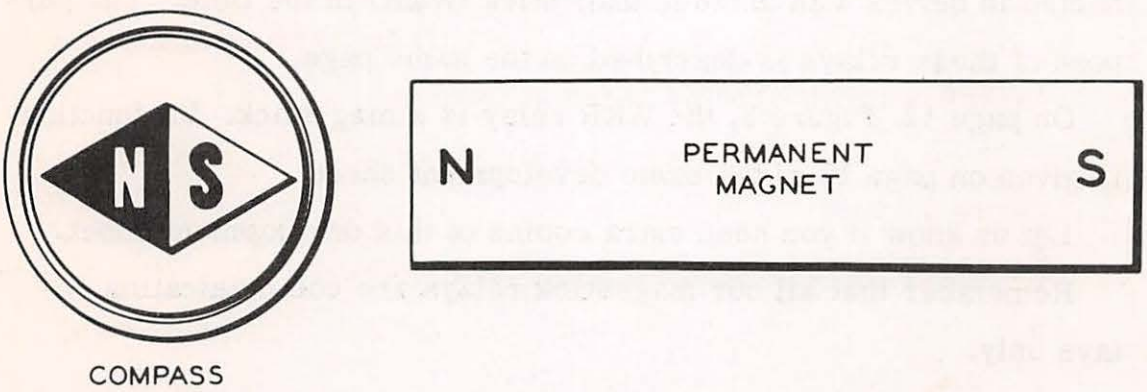

N
S
N
PERMANENT
MAGNET
S
COMPASS

Figure 24. How we mark a magnet.

Alnico is hard and brittle, so should not be dropped or pounded. Magnets should always be treated with care.

A. How We Mark our Magnets

The following is our practice in marking magnets:

1. Place a compass near one end of the magnet and note which end of the compass needle is nearer the magnet. See Figure 24.
2. Suppose the south-seeking end of the compass needle is nearer the magnet. We stamp that end of the magnet with the letter "N", usually with yellow or blue paint.

B. Some Magnets are not Marked

In some instances you will find magnets assembled into relays without bearing any markings. This is true of Type A mag-sticks. The assembler is guided by the assembly instructions which specify, in brief: "...the end attracting the north-seeking end of the compass shall be placed...etc., etc."

C. Charging Magnets

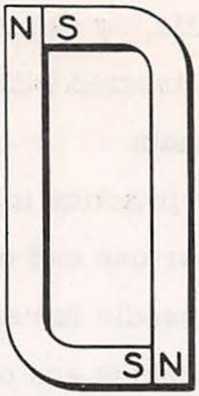
After a magnet has been magnetized, it is our practice to demagnetize it to something less than full strength. This is done to produce a stable magnet — one that will hold almost constant residual throughout the years it's in service.

The flux value and date are also stamped on each magnet.

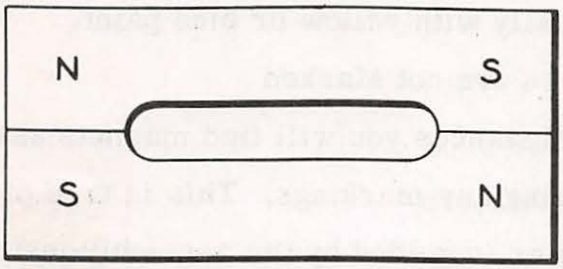
D. Storing Magnets

If magnets are taken out of a relay or other device, they should be stored in clean trays — away from metallic filings, metallic dust, and strong magnetic fields.

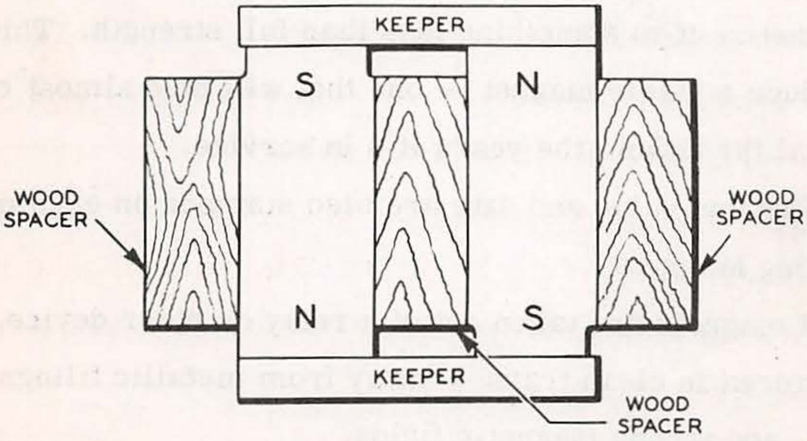
When stocked in pairs, they should be placed with unlike poles next to one another. The L-shaped magnets of A relays can be locked together thus:



The magnets of B relays can be locked together thus:



The cylindrical magnets of K relays should be kept apart with wooden spacers; and steel bars, "keepers", should be used to connect the unlike poles thus:


KEEPER
S
N
WOOD SPACER
WOOD SPACER
N
S
KEEPER
WOOD SPACER

E. Checking Magnets

It's a good idea to check magnets for residual just before assembling them. You are that much surer of getting the right working values out of your relays.

* * *

G-R-S and Philips Form New Signal Company in Holland

G-R-S, Rochester, and the Philips Incandescent Lamp Works of Eindhoven have formed a company to produce railway signals in Holland. The Netherlands Railways are cooperating in the establishment of the new undertaking. Orders placed by the Netherlands Railways with G-R-S will be carried out by the new Dutch concern, Spoorweg Sein Industrie (Railway Signal Industry).

* * *

Lawrence Chir Dies

It came as a shock to all of us when we heard from London, England that Lawrence Chir had died on his way home from India.

Lawrence Chir

Lawrence will always be remembered by us as the tall, athletic English lad who spent several months in Rochester as a trainee seventeen years ago. His friendly, easy manner quickly attracted the office and factory people he met here. He was a serious, inquiring student, out to learn all he could while he was with us.

Lawrence had joined General Railway Signal Company Limited in 1929, coming from the London Underground Railways. After his training in Rochester he was appointed representative of G-R-S Ltd., first in South Africa, later in South America and then in India.

He spent ten years in India during which time he made many friends in the railway world. He returned to England in 1944.

On January 1, 1947, at the age of 40, he was appointed commercial engineer of Metropolitan-Vickers-G-R-S. He had recently been on a tour to India to introduce Mr. J. O. Sims, who is now the technical representative of the signal company attached to Associated Electrical Industries (India) Limited.

On his way home, Lawrence was taken ill with typhoid fever and put off the boat at Aden, where he died at midnight on October 23.

An associate member of the Institution of Electrical Engineers and a member of the Institution of Railway Signal Engineers, Lawrence will be sadly missed by his many friends and associates all around the globe.

To his bereaved wife and relatives we send our sincere sympathy.

* * *

We're Moving into the New Engineering Building

The long-awaited day of moving into our new engineering building is at hand. Blueprint, photostat, and drafting are settled in their new quarters. The engineering offices are now being transferred.

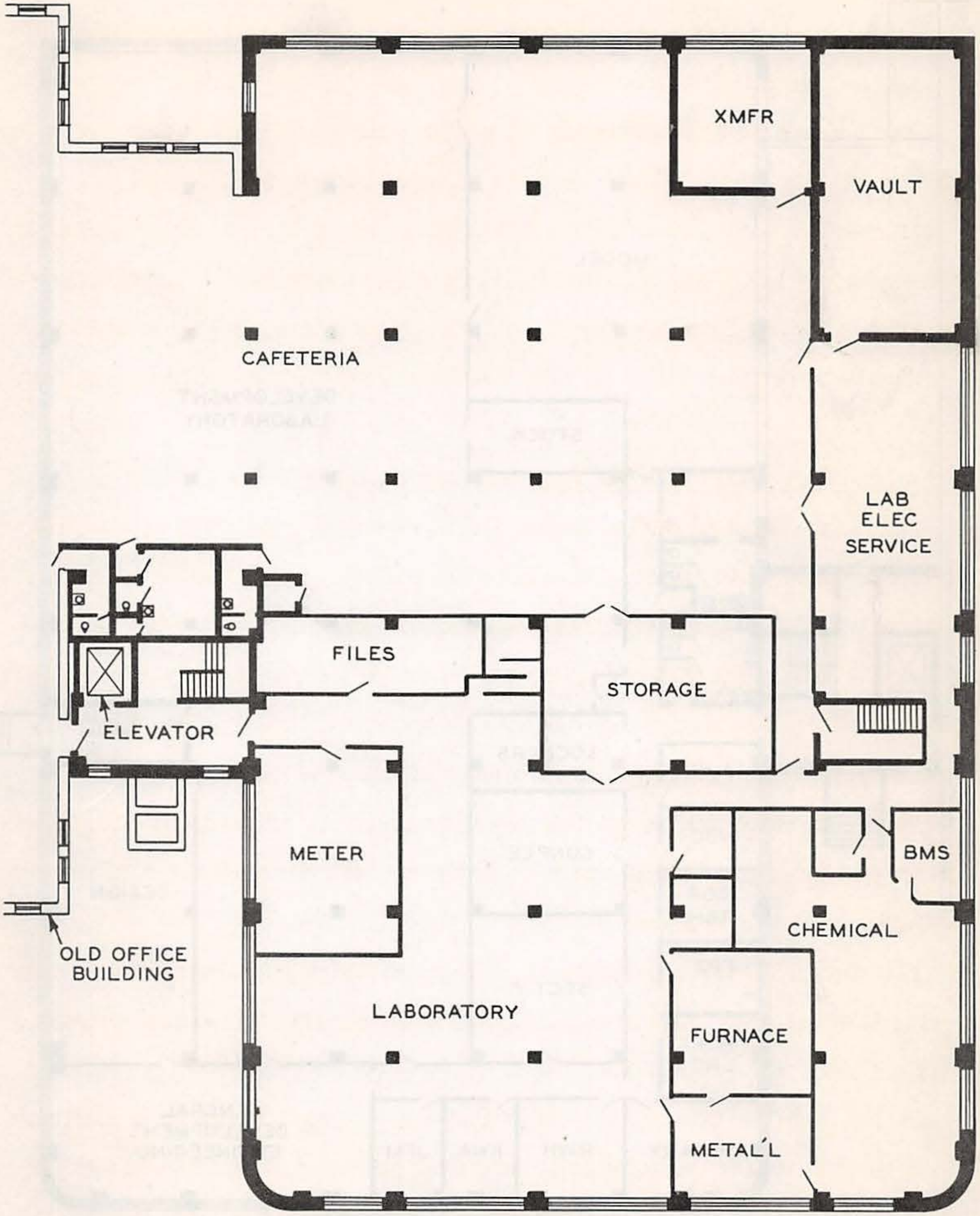
In the basement there will be the transformer and lab power supply rooms, vault, chemical and metallurgical labs, and storage rooms. The present cafeteria will extend into part of the new basement.

The first floor will have the development lab, model and design rooms, library, conference room, development engineers' offices, and the stenographic and file rooms.

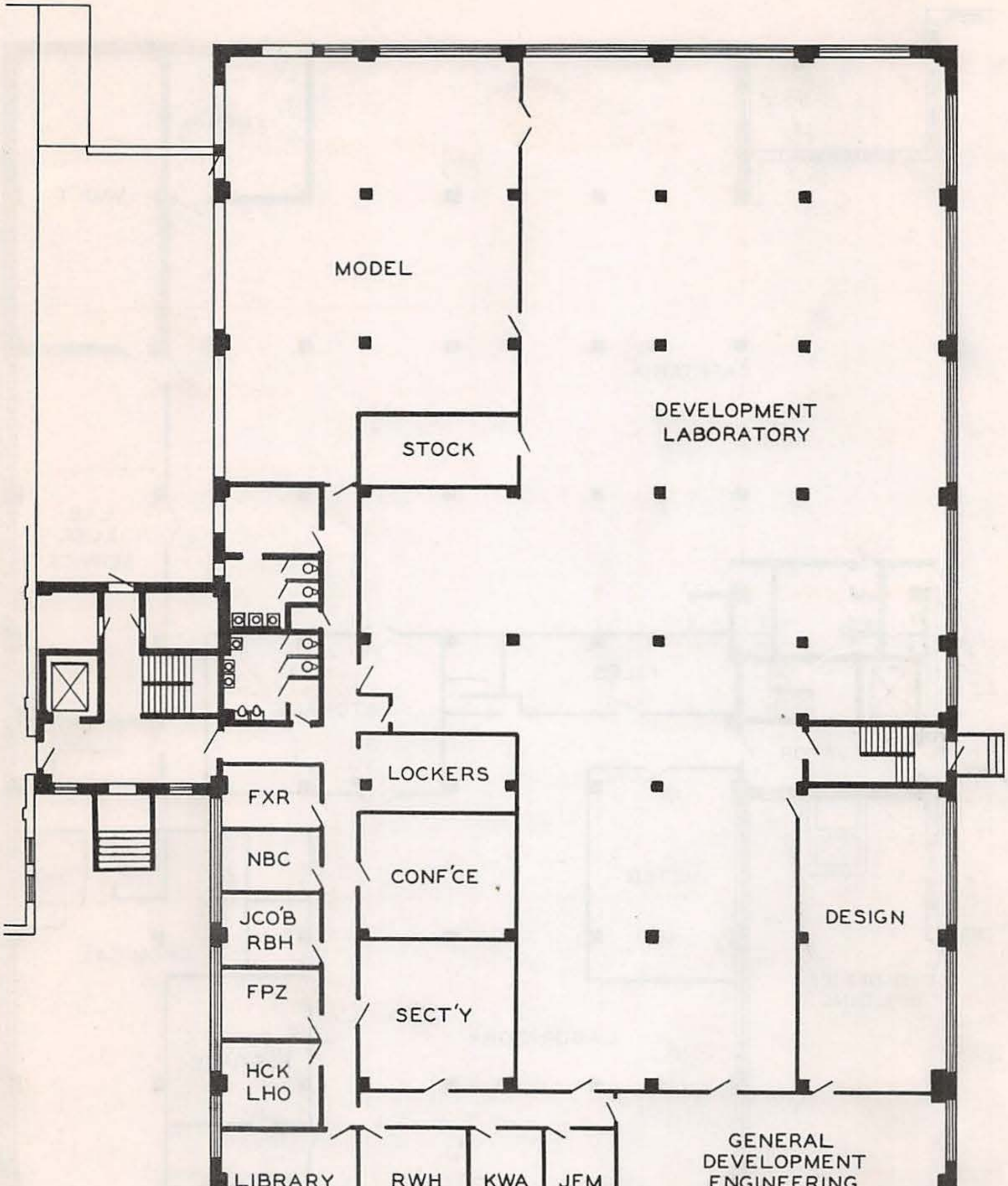
The second floor has drafting, blueprint, and photostat rooms, electrical laboratory, general engineering offices, and the engineering clerical office.

On the roof is a radiation lab. The roof is on a level with the third floor of the old office building. The new office is constructed strong enough to support additional floors, when required.

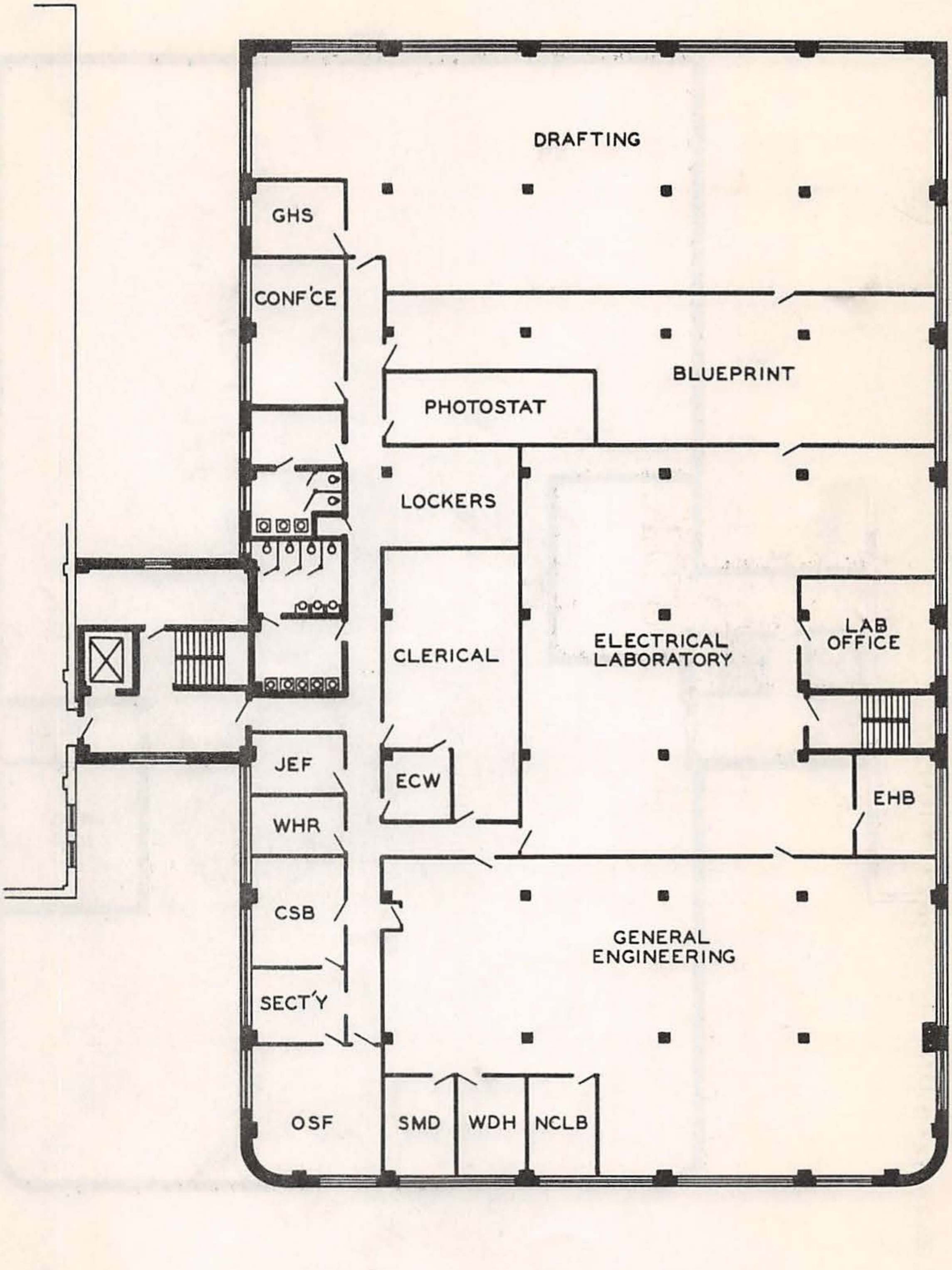
The new office building is connected to the old by passageways. A stairway and elevator serve all floors.


XMFR
VAULT
CAFETERIA
LAB
ELEC
SERVICE
FILES
STORAGE
ELEVATOR
METER
BMS
CHEMICAL
OLD OFFICE
BUILDING
LABORATORY
FURNACE
METAL'L

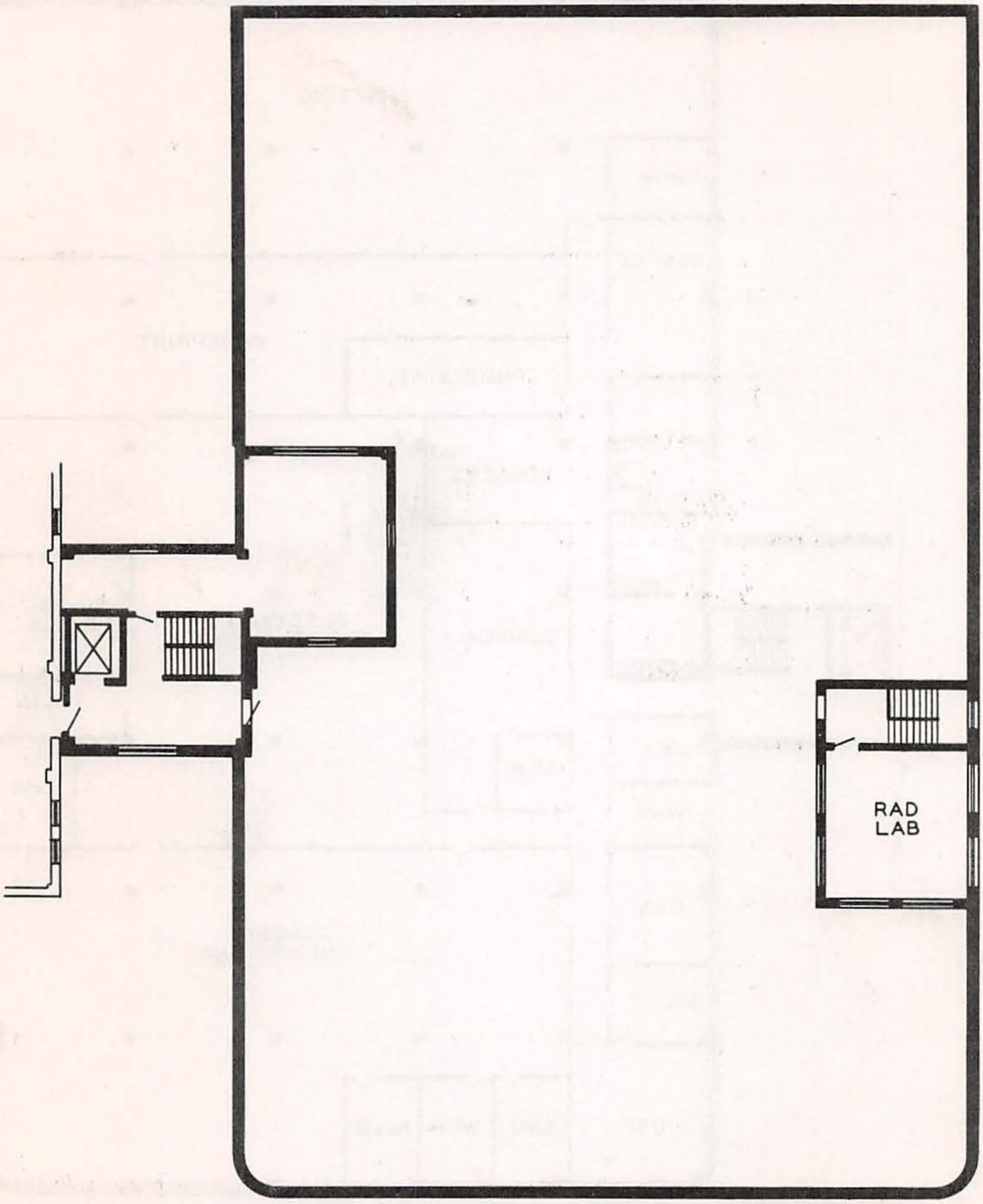
Basement of new engineering building.


MODEL
STOCK
DEVELOPMENT LABORATORY
LOCKERS
FXR
NBC
CONF'CE
JCO'B RBH
FPZ
SECT'Y
HCK LHO
DESIGN
LIBRARY
RWH
KWA
JFM
GENERAL DEVELOPMENT ENGINEERING

First floor of new engineering building.


DRAFTING
GHS
CONF'CE
BLUEPRINT
PHOTOSTAT
LOCKERS
CLERICAL
ELECTRICAL LABORATORY
LAB OFFICE
JEF
ECW
EHB
WHR
CSB
GENERAL ENGINEERING
SECT'Y
OSF
SMD
WDH
NCLB

Second floor of new engineering building.



Roof of new engineering building.

G-R-S NEWS
January 1948

Some Changes in G-R-S Cab Signaling

The New York, New Haven and Hartford Railroad has bought on CM5372 the latest G-R-S cab signal equipment for 30 Alco Diesel-electric locomotives. The new signal works the same as the older G-R-S type used by the railroad, but has a re-designed housing which fits smoothly into the cab trim as a built-in unit. See Figures 1 and 2.

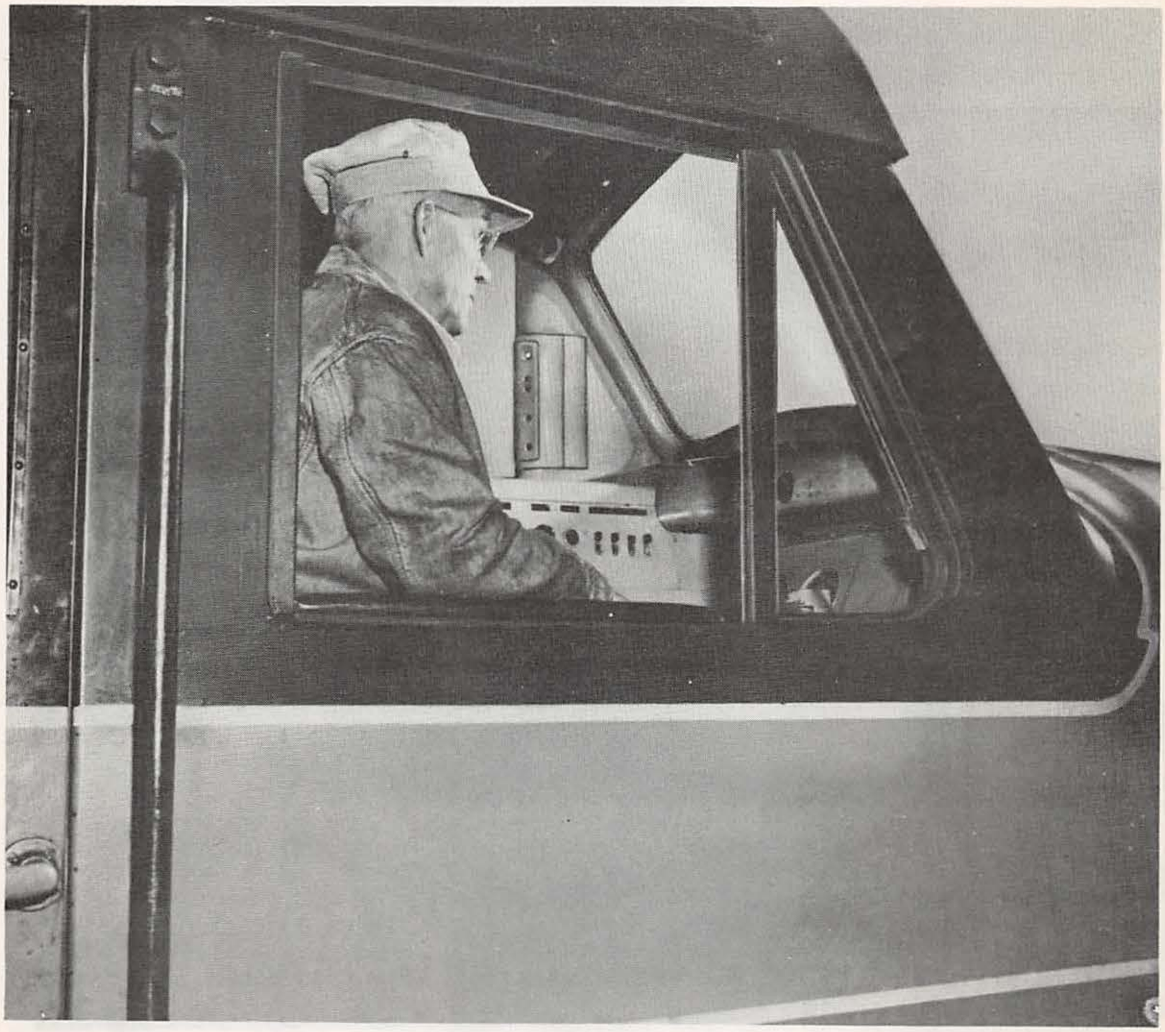


Figure 1. Alco Diesel-electric locomotive equipped with G-R-S cab signal.

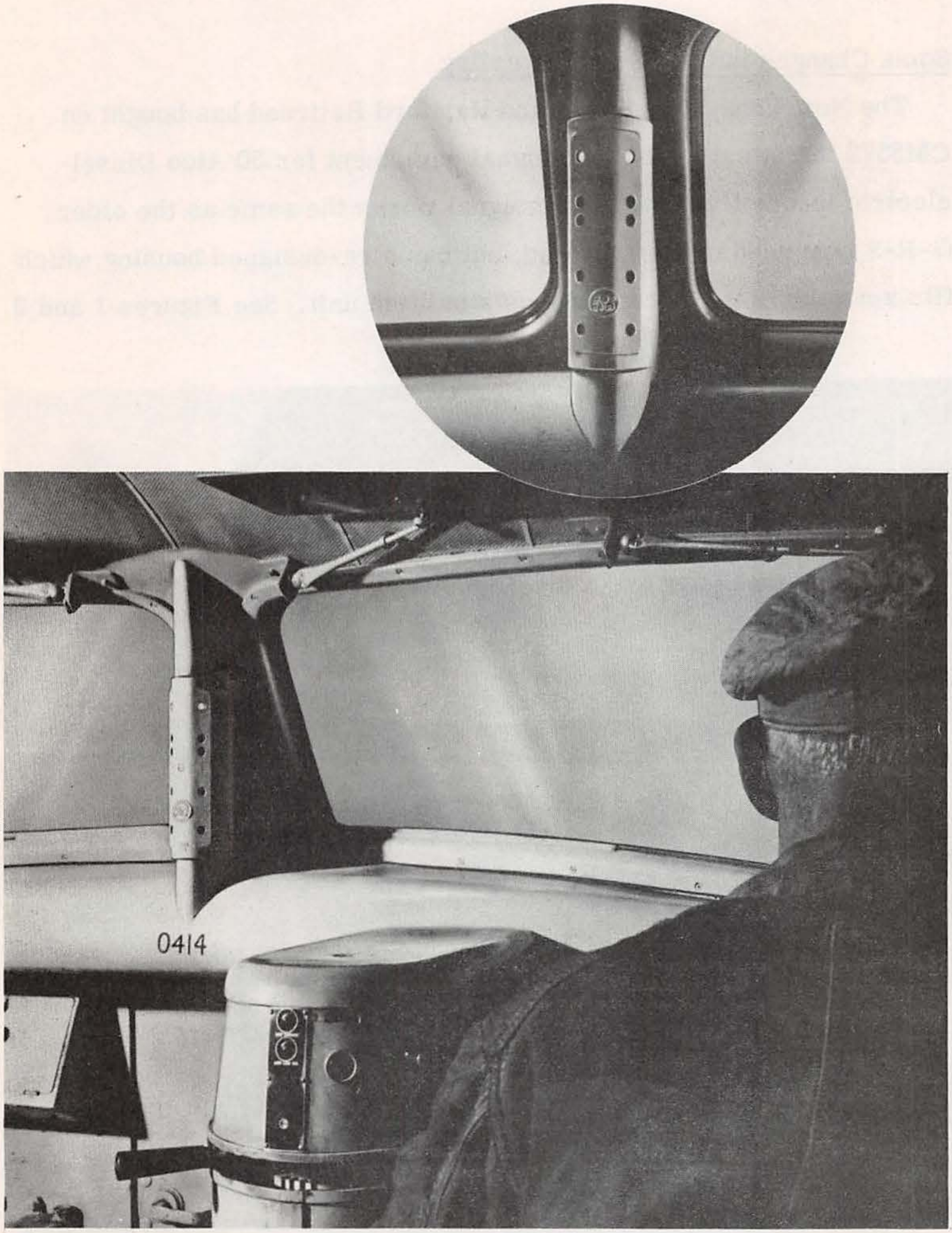


Figure 2. The cab signal is shaped to fit the trim.

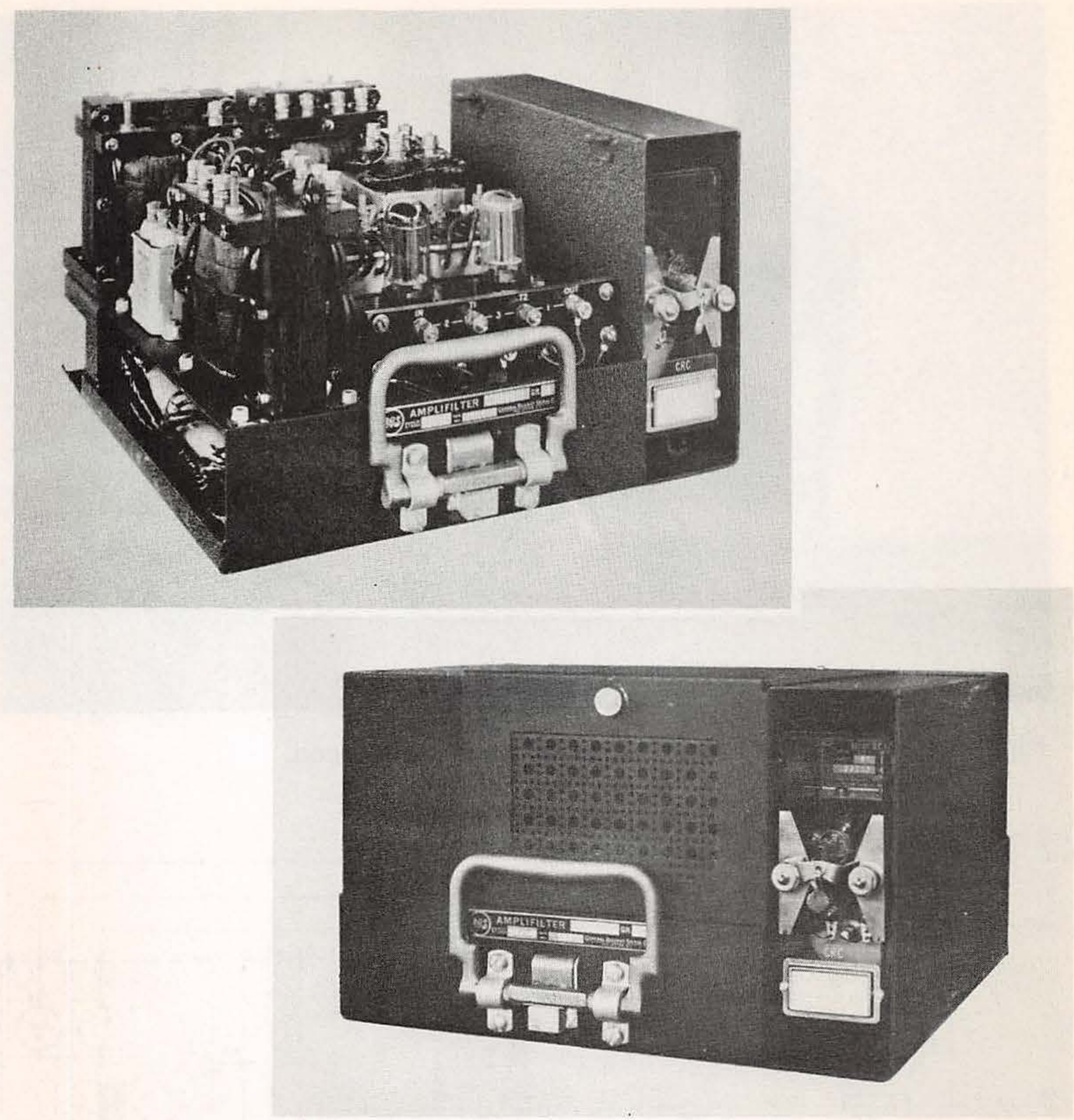


Figure 3. New amplifilter unit.

Another change on the new locomotives, and more important from a technical standpoint, is in the cab-signal circuits. A beam-power tube amplifilter, Figure 3, is now used and operates directly from the 32-volt supply. The dynamotor, which was needed to generate high voltage for the old triode amplifilter, has been eliminated, thus simplifying equipment and reducing maintenance.

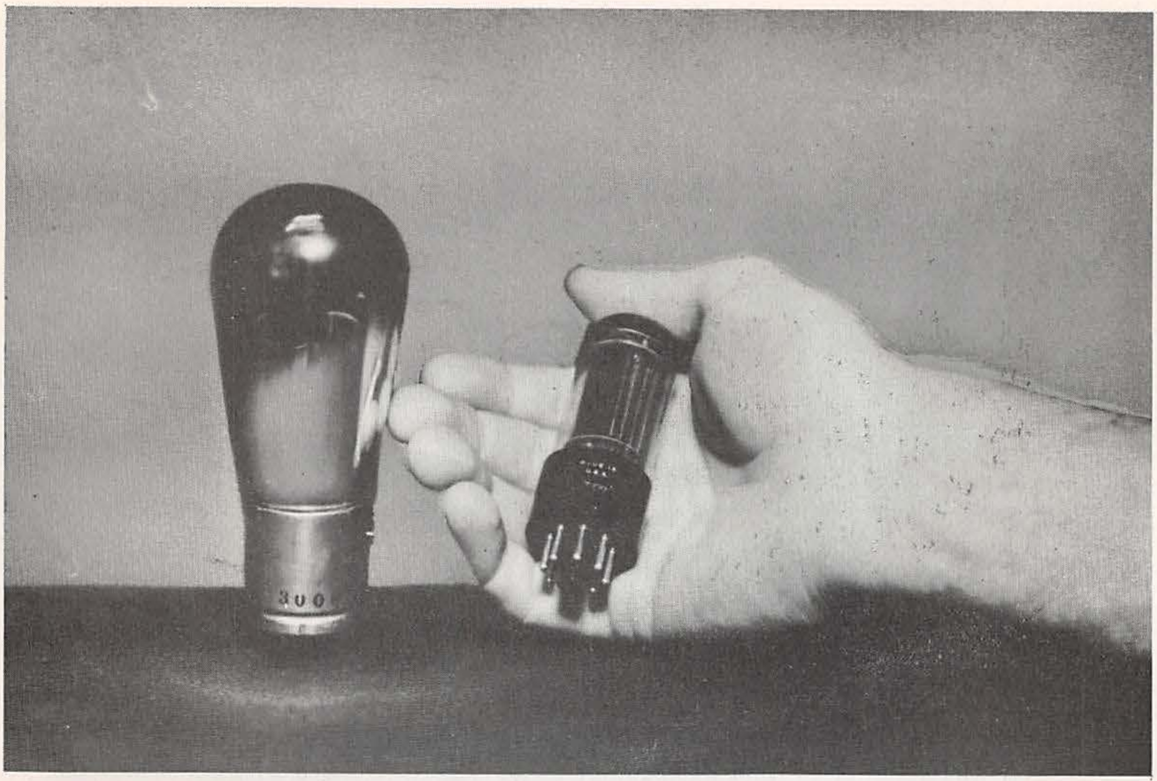


Figure 4. Single triode and twin pentode compared.

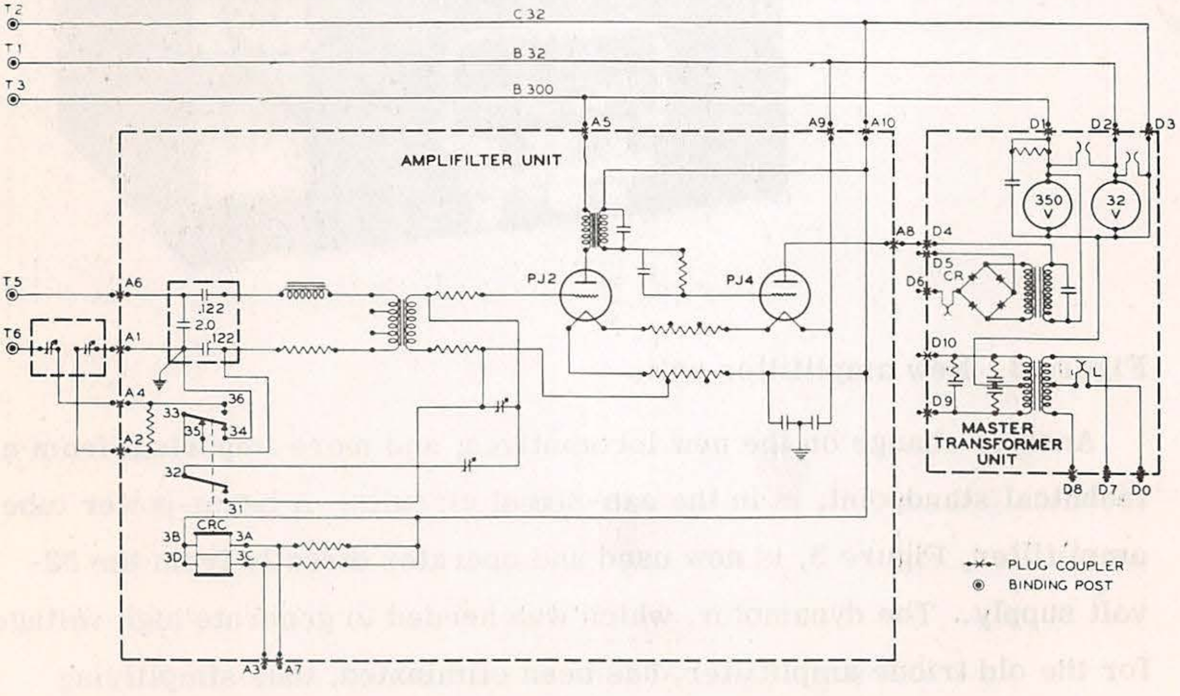

T2
T1
T3
C 32
B 32
B 300
A5
A9
A10
D1
D2
D3
AMPLIFILTER UNIT
350 V
32 V
A8
D4
D5
D6
CR
PJ2
PJ4
T5
T6
A6
A1
.122
2.0
.122
A4
A2
33
35
36
34
32
31
CRC
3B
3D
3A
3C
A3
A7
D10
D9
L
MASTER TRANSFORMER UNIT
D8
D7
D0
PLUG COUPLER
BINDING POST

Figure 5. The old amplifilter circuit (part of 56318-8).

The new amplifilter uses two 26A7GT tubes. The 26A7GT is a twin tube with two beam-power pentodes in one envelope. Typical screen and plate voltage for this tube is 26.5 volts, which is the same as the required heater voltage, so that the tube is readily used on a 32-volt d-c. supply. It is interesting to note how compact the modern twin pentode is compared with the old single triode, Figure 4.

Figure 5 is part of cab-signal circuit 56318-8. It shows the amplifilter, master transformer unit, and some external connections. This circuit (which will be found complete on page 17, Handbook 22) uses triode tubes and is the original hook-up on New Haven Diesels.

Figure 6 is the same portion of circuit 56318-13, the circuit used on the new locomotives. The rest of 56318-13 is the same as 56318-8 with the following slight differences (not shown in Figure 6):

1. Relay L in 56318-8 is replaced by LLV in 56318-13.
2. Relay CR in 56318-8 is replaced by CRLV in 56318-13.

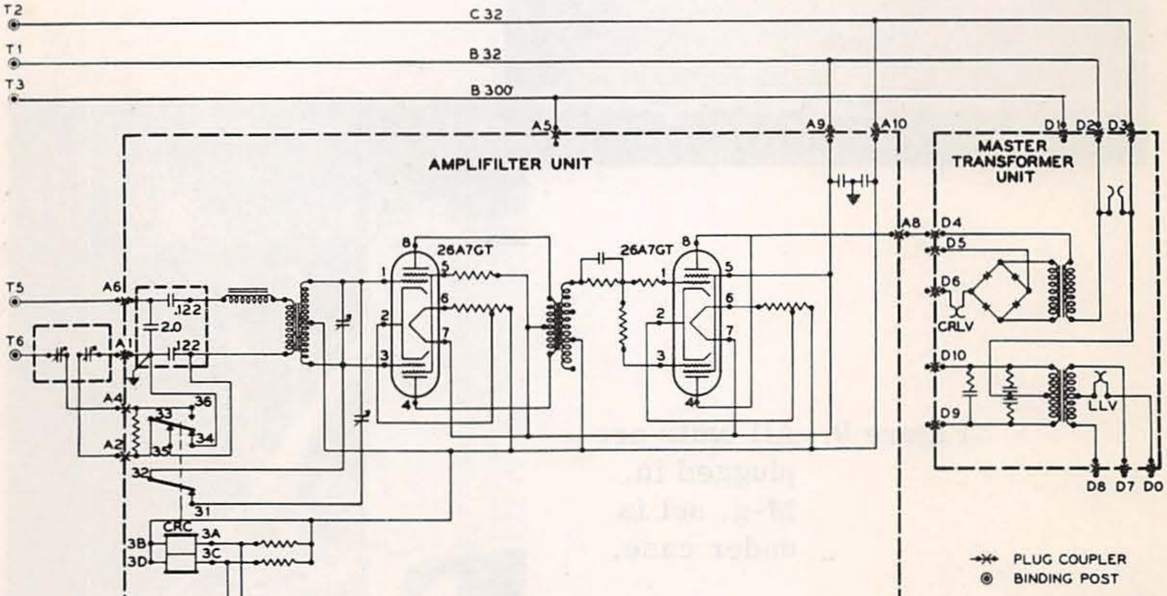

T2
T1
T3
C 32
B 32
B 300
A5
A9
A10
D1
D2
D3
AMPLIFILTER UNIT
MASTER TRANSFORMER UNIT
A8
D4
D5
D6
CRLV
D10
D9
LLV
D8 D7 D0
26A7GT
26A7GT
T5
T6
A6
.122
2.0
.122
A1
A4
A2
33
36
34
35
32
31
CRC
3A
3B
3C
3D
A3
A7
PLUG COUPLER
BINDING POST

Figure 6. The new amplifilter circuit (part of 56318-13).

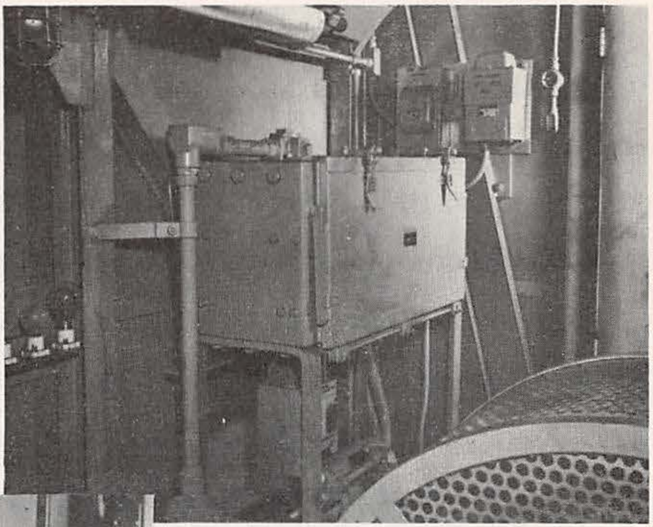


Figure 7. The equipment case is in the engine room of the A unit.

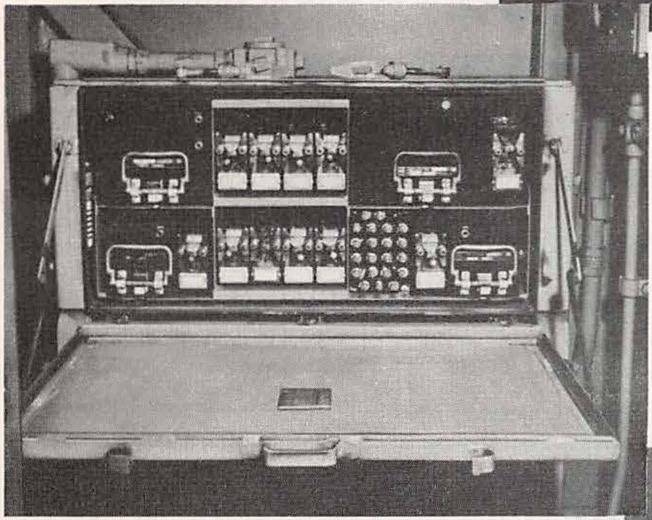


Figure 8. The inner frame is shock-mounted in the outer case.

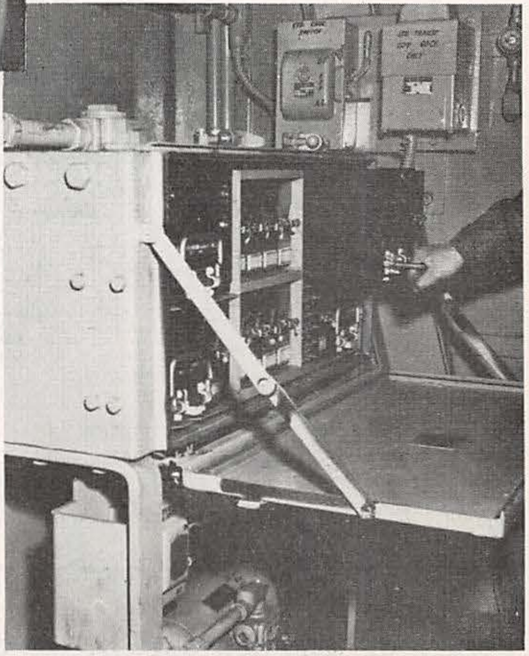


Figure 9. All units are plugged in. M-g. set is under case.

Relays LLV and CRLV do the same job as L and CR, but have modified characteristics to work better with the new amplifilter.

Figure 5 shows that the old amplifilter uses two triodes in a transformer-coupled circuit. Each stage is single-ended, and supplied with high voltage from the dynamotor.

The new amplifilter circuit, Figure 6, is also transformer-coupled, but has these new features:

1. All plate and screen voltages come from the B32 bus.
2. The first tube is used as a push-pull amplifier, which reduces the effect of ripple in the 32-volt supply.
3. The second tube is used with its two sections in parallel to get increased output.

The output of the new amplifilter controls the code-following relay CRLV, the same as the old unit controlled its code-following relay CR.

The B300 wire which supplies plate voltage to the PJ2 triode in Figure 5 is still included in the new equipment cases, but is not connected. This has been done to keep equipment cases semi-interchangeable. That is, the old type amplifilter and master transformer unit can still be used on the new cases after making some minor changes in the plug connectors.

Figures 7 and 8 show how the equipment case is conveniently located inside the locomotive. The plug-in feature of the various units is seen in Figure 9, which shows the amplifilter being withdrawn from the equipment case.

* * *

Signaling Statistics, 1947

Based on the Statistical Issue of Railway Age, dated January 3, 1948, the following is a comparison of the signaling and the train communication systems furnished by the major signaling and communication companies and put in service in 1947:

CENTRALIZED TRAFFIC CONTROL

	Union	GRS
Track-miles	1505.9	340.1
No. of levers	1087	291
Power switches	378	158
Signals	2124	539

BLOCK SIGNALING

	Union	GRS
Track-miles	1212.1	793.1
Signals	1354	955

ALL-RELAY INTERLOCKING

	Union	GRS
Signals	166	362
Switches	97	232

AUTOMATIC INTERLOCKING

	Union	GRS
Signals	32	51

CAR RETARDERS

	Union	GRS
Tracks	44	-
Retarders	23	-
Rail-feet retarders	1,586	-
Switches	46	-
Track circuits	46	-
Signals	8	-
Skates	-	-
No. of towers and control machines	4	-

TRAIN COMMUNICATION - ROAD

	Bendix	Aireon	GRS
Locomotives	6	21	-
Cabooses, etc.	4	29	-
Wayside	-	8	-

TRAIN COMMUNICATION - YARD

	Bendix	Union	GRS
Locomotives	129	11	28
Wayside	23	4	7
Rem. Con. Sta.	18	-	1

* * *

Franklin George Made Sales Engineer, New York

As of January 5, Franklin George, assistant advertising manager, transferred to New York office as sales engineer.

Frank was born in Dorchester, Mass. on October 3, 1907, and attended the grammar and high schools in Warner and Hopkinton, New Hampshire.

In June, 1922 he took a job as maintainer with the Hopkinton Telephone Company. A year later he joined the New Hampshire Power Company doing maintenance work. During these periods of employment he completed the Chicago Engineering Works correspondence course in Practical Electrical Engineering.

In April 1926 he joined the signal department of the Boston and Maine as signalman, leaving three years later to become signal foreman on the Canadian Pacific at Toronto.

In October 1940 Frank came to G-R-S as copywriter in the advertising department. During the next seven years he served as foreman in the installation department on three important jobs -- C.T.C. on the C.N. from Moncton to Truro; all-relay interlocking on the C.N. at St. Lambert's; and C.T.C. on the B.&M. from Soapstone to Williamstown, Mass. He spent a few months as engineer in the commercial department and was assistant advertising manager from September, 1943, until his recent transfer.

Frank is the rare combination of engineer and writer with both a theoretical and a practical background. He has written articles for Railway Signaling and Signalman's Journal and was secretary for the B.R.S. of A. local in Toronto. He is a member of the Toronto Railway Club and has a wide circle of friends on the eastern Canadian and New England railroads.

We wish him good luck and much happiness in his new work.

* * *

George Seidel Retires

George M. Seidel, about 30 years with G-R-S, retired to go live on the West Coast with his son. George was last employed in the mailing room of the advertising department. His biography is steeped in the early history of G-R-S signaling and may be interesting to many in our organization.

George was born December 7, 1862 at Rock, Pa. Of his schooling and early life we have no record. In 1884 we know that he was a telegraph operator on the Reading and in 1888 a leverman at a mechanical plant at Park Junction, Philadelphia.

From 1893 to '96 he was maintainer at an electro-pneumatic plant at 12th and Market Streets, Philadelphia and Reading Terminal. From 1896 to 1903 he had a variety of jobs on the Reading in the general store, express office, ticket office, post office, telegraph office, and in the signal gang. In 1904 he maintained a G-R-S electric interlocking in Michigan; in 1906 he installed the G-R-S plant on the B.&O. at 24th and Chestnut Streets, Philadelphia; then moved to New York for installation work on the Electric Zone.

In 1907 George was in the Rochester office working on circuits for the Hudson & Manhattan Tunnel job, various appliance exhibits in Chicago and Atlantic City. In 1910 he went out to Westminister, British Columbia, to test out a G-R-S interlocking on the Fraser River drawbridge; then to Spokane to put in 30 miles of G-R-S automatics. On this installation a special arm was used on the signal to reach over the trolley to break a glass tube set in the service brake pipe, should the trolley overrun the signal. Then to Oakland, California to work with Dan Murphy on a signaling job on the Key Route.

In 1913 George had charge of maintaining signals on the New York State Railways from Rochester to Sodus Point, and Rochester to

Geneva. W. K. Howe says of him: "George Seidel was one of the best signal maintainers I ever knew. He could make those old star-wheel hold-clears work when others were returning them to the factory."

After a year spent in the inspection department George went to East St. Louis in the spring of 1926 on the Type A retarder job for the Illinois Central. From 1927 to 1931 he was on several retarder installations, Mechanicville, Selkirk, and Oak Island.

After a short spell out West, near Vancouver, B.C., on the C.P.R., he was engaged on C.T.C. construction on the B.&O., Gilkeson, Pa. to Wheeling, West Va. Then the Great Depression -- and George worked as janitor and guard for nearly eight years. In 1939 he was placed in the mailing section of the advertising department where he remained until his retirement.

We will all miss his dry humor and homely philosophy. We know he will have much to do in his retirement for he is interested in a number of hobbies, not the least being the younger generation, whose company he greatly enjoys.

* * *

GENERAL RAILWAY SIGNAL COMPANY

G-R-S NEWS

February 1954

In this issue:

- Portable cab signal test unit.
- Portable test unit for frequency-responsive speed governor.
- Portable test units for wheel slip and slide detector.

An important factor in maintaining signal systems and appliances at peak operating efficiency is the availability of adequate test equipment. This issue describes three test units which enable a maintainer to make rapid and accurate tests on three different types of G-R-S equipment.

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* There were no issues of G-R-S NEWS during 1952.

PORTABLE CAB SIGNAL TEST UNIT

A portable cab signal test unit has been developed for checking the sensitivity and operation of cab signal equipment. This device is intended for use at locations where permanently installed test equipment is not available.

The test unit, Figure 1, is housed in a metal case approximately 10 by 10 by 17 inches, and can be carried and operated by one man. The unit includes a vacuum tube oscillator which furnishes switch-selected a-c. outputs of 60, 100 and 140 cycles per second, available at a pair of terminal posts on the panel. A variable rheostat control, located on this same panel, provides continuous control of output current over ranges of 0 to 1 and 0 to 10 amperes, with output indicated by an ammeter in the output circuit.

Coding of the a-c. output is accomplished by three cams which are rotated by a small synchronous motor. There is a cam for each of the code rates: 75, 120 and 180 pulses per minute. The desired code rate is selected by a switch on the front panel. In addition, this switch has an "ON" position which provides for steady a-c. output.

A pilot light indicating "power on" and a fuse are also located on the panel.

If one man is making the test, the unit may be used in the cab with the leads run out through the cab window. Test leads are not included as a part of the test set because different lengths will be needed under different conditions. If a permanent track test loop is used, the test unit is connected directly to the loop leads. If, however, there is no permanent loop, the leads from the test unit are formed into a temporary loop and tucked under the front wheels of the locomotive and along the tracks and back again, as shown in Figure 1.

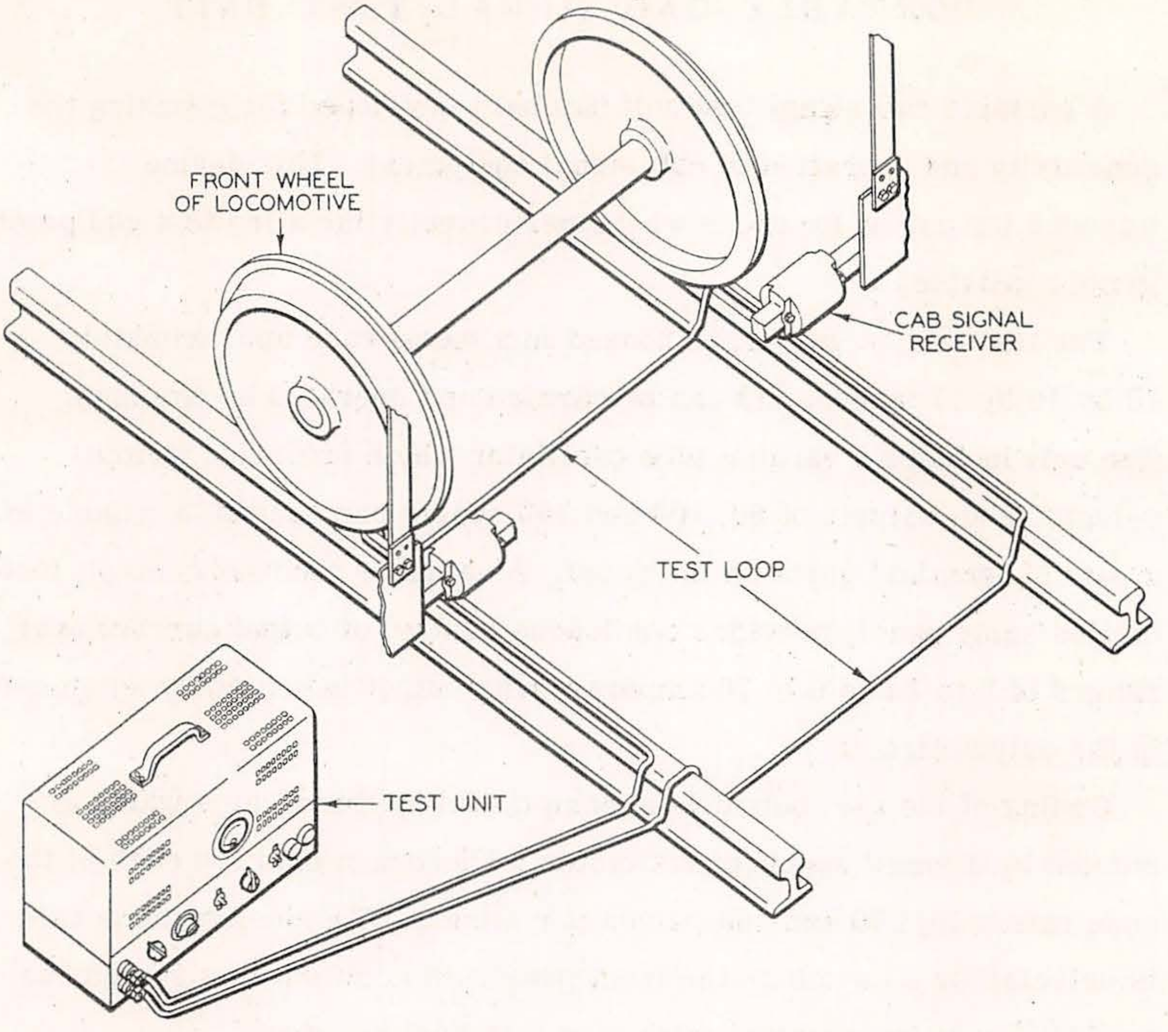

FRONT WHEEL OF LOCOMOTIVE
CAB SIGNAL RECEIVER
TEST LOOP
TEST UNIT

Figure 1. Portable cab signal test unit and test loop.

The test unit is easy to operate. The procedure is:

1. Bring the unit into the position desired and connect leads to the terminals marked "test loop". Then connect to the test loop.
2. Set the rheostat to zero, and set the ammeter to the high scale range, 0 to 10.
3. Connect power (115 volts, 60 cycles) and turn the test set on.
4. Set the frequency selector switch to the proper value for the cab signal equipment.
5. Turn the code rate switch to the desired position.

6. To check sensitivity, slowly increase the current output into the loop until proper response of the signal is obtained. Then turn the code rate switch to the "ON" position and read loop current on the meter.
7. To check the overall performance of the locomotive equipment, set the loop current at a specified test value and note the response of the cab signal system as the code rates are changed.

Maintenance of the test unit ordinarily consists of replacing tubes and fuses. Tubes are readily replaced after removing the cover.

GENERAL RAILWAY SIGNAL COMPANY

PORTABLE TEST UNIT FOR THE FREQUENCY - RESPONSIVE SPEED GOVERNOR

A portable test unit has been designed for checking the FR (frequency-responsive) speed governor, described in G-R-S News, August 1953. The unit will be used primarily for routine inspection tests while the engine is on the service rack. However, tests may also be made with this unit while the engine is in the yard or even with the engine in service.

The test unit, Figure 2, measures 9-1/4 by 6-3/4 by 7-3/4 inches, weighs 14 pounds, and can be easily handled and operated by one person. By means of a Wien-bridge type electronic oscillator, isolated by a cathode follower output stage, the test unit simulates the a-c. output of the axle generator. The frequency of this signal is varied by means of the MPH control dial on the instrument panel. This dial is calibrated not in frequency, but in the train speed in mph. which corresponds to the equivalent axle-generator frequency of the speed governor at that speed. An output gain control adjusts the voltage level of the test signal. The speed range covers 5 to 125 mph., and a selector switch divides this into ranges of 5 to 25 and 25 to 125 mph.

A wheel-size selector switch is incorporated with provisions for simulating outputs of a 36- or 40-inch diameter wheel. Wheel size is important, because for a given train speed, wheels of different sizes will rotate at different rpm. and the axle-generator frequency will be directly affected. The test unit also includes a five-position switch labeled CHECK, which in addition to turning the unit on, is used to select the tests required for a complete check of the governor. A meter located directly above the CHECK switch indicates the condition of the various circuits and functions of the system. To facilitate testing, the meter, instead of carrying conventional voltage and current scales, is divided

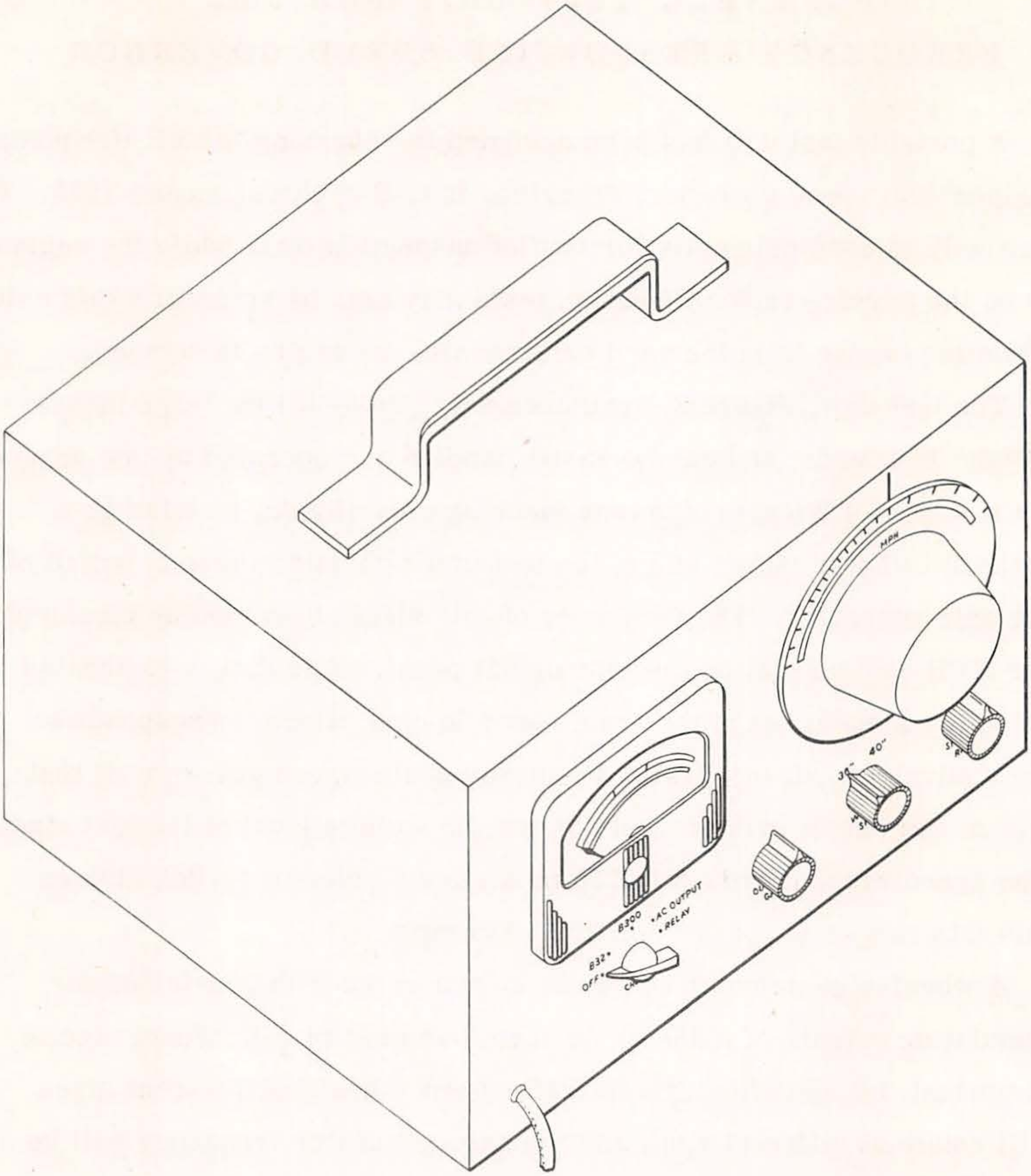


Figure 2. Portable test unit for frequency-responsive speed governor.

into three clearly marked zones. The center zone of the meter indicates "good", while the lower and upper zones indicate readings beyond acceptable test tolerances. The meter circuits are so arranged that when the function under test is exact in value or adjustment, the meter needle reads center scale, ie., in the middle of the center zone. The boundaries of the center or "good" zone represent acceptable variations on either side of exact center. All power and test circuit connections required for the test unit are made through a single cable, plug connected to the FR governor mechanism, which is usually located in the diesel cab or nose. No external power connections are required.

The test set is put into operation by inserting the cable connector into the receptacle provided for it. This receptacle is located on the outside of the governor mechanism case and is protected by a "slide-away" cover. The first two positions of the CHECK switch provide preliminary voltage checks. By moving the switch to B32, the test unit is turned on, and checks the voltage obtained from the train control motor-generator set. When the CHECK switch is turned to B300, the test unit checks the voltage of the dynamotor which furnishes power to the plates of the tubes used in the speed governor.

The signal output of the test unit is then adjusted by turning the CHECK switch to A-C OUTPUT, and setting the meter needle to center position by means of the output gain control. This level is essentially the same as the voltage produced by the axle generator under normal operating conditions. Turning the CHECK switch to RELAY now applies the output signal to the governor mechanism. The condition of the output tube in the speed governor mechanism is then checked by setting the MPH dial to a value above the permissible speed, and the meter indication noted.

Assuming that the output tube is in satisfactory condition, a complete check of the speed response of the FR governor can now be made by setting up appropriate train speeds on the MPH dial and noting the response of the warning whistle and electro-pneumatic valve. As previously described in G-R-S News (August, 1953) the warning whistle should sound intermittently when speed is between maximum permissible and 3 mph.

less; when speed exceeds the maximum permissible, the electro-pneumatic valve should become deenergized to cause an automatic brake application.

The test unit is sturdily constructed and uses special "ruggedized" tubes. Under ordinary conditions the unit will give years of trouble-free service.

GENERAL RAILWAY SIGNAL COMPANY

PORTABLE TEST UNITS FOR THE WHEEL SLIP AND SLIDE DETECTOR

Two portable test units will be manufactured for checking wheel slip and slide detector equipment. One unit is designed to make tests over a wide range of operating speeds, and provides for maximum flexibility of testing. This unit will be used at regionally located diesel shops, by men qualified to do overhaul and repair work on the slip and slide detector. The other unit is a simplified version, using a minimum of controls, and is intended for routine maintenance checks by personnel at division and terminal points.

Figure 3 shows a developmental model of the unit designed for detailed test work. This unit includes two Wien-bridge oscillators, similar to the oscillators used in the test unit for the FR speed governor. As in the latter test unit, these oscillators provide outputs which simulate the output of the axle generator. By using two oscillators, with independent control of each, it is possible to simulate not only wheel speed, but also differences in wheel speed corresponding to slip and slide. The two large dials, labelled TRAIN SPEED and SLIP SPEED, control the oscillator frequencies. These dials are calibrated directly in miles per hour, and provide two output ranges: 5-25 and 25-125 mph., as selected by the switches immediately below each dial. Also included on this test unit are two switches, called the CHECK switch and the AXLE switch, and a meter of the "three-zoned" good-bad type similar to the one used on the FR speed governor test unit.

A complete test consists of moving the CHECK switch clockwise through each position and noting the results, either as indicated by the meter or by the response of the slip and slide detector.

After tests (to be described) have been made on B70 and B275,

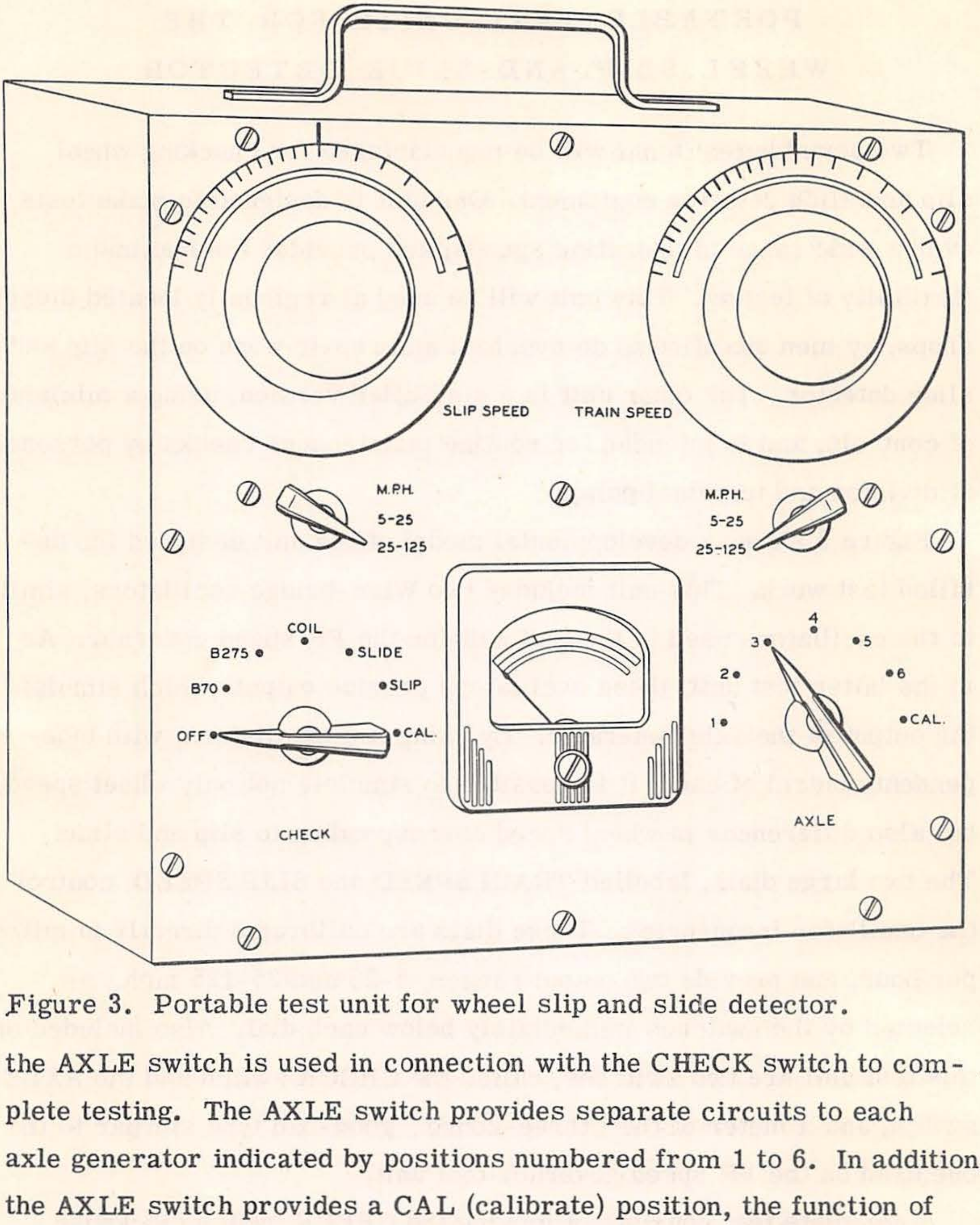

SLIP SPEED
TRAIN SPEED
M.P.H.
5-25
25-125
M.P.H.
5-25
25-125
COIL
B275
SLIDE
B70
SLIP
OFF
CAL.
CHECK
4
3
5
2
6
1
CAL.
AXLE

Figure 3. Portable test unit for wheel slip and slide detector.

the AXLE switch is used in connection with the CHECK switch to complete testing. The AXLE switch provides separate circuits to each axle generator indicated by positions numbered from 1 to 6. In addition, the AXLE switch provides a CAL (calibrate) position, the function of which is described later.

To make a complete check of the wheel slip and slide detector equipment the test unit is plugged into the receptacle on the mechanism case. A single cable brings energy to operate the test unit and makes connections necessary for testing. The CHECK switch is then turned to the positions tabulated below and the meter readings noted.

B70 - turns the test unit on and makes a check of the voltage supplied to the wheel slip and slide detector from the battery bus of the diesel.

B275 - checks the output voltage of the dynamotor used in the wheel slip and slide detector system.

COIL - checks continuity of the coils and leads of each axle-driven frequency generator. As part of this test, the AXLE switch is turned to the numbers representing each axle generator. This checks successively the coils of the individual generators. An open circuit in any coil is indicated by an up-scale meter reading, and a shorted or partially shorted coil is shown by a down-scale reading.

SLIDE - applies a speed signal, indicated by the TRAIN SPEED dial, to all axle generators except the one indicated by the AXLE switch. This, in effect, is the same as a slide condition where one wheel is locked and is not producing a frequency output. Hence the system will indicate an out-of-synchronous condition; that is, all axles are not rotating at approximately the same speed. If the system is left in this condition for longer than 15 seconds, the slide alarm bell should sound and the slide indicator lamp should light on the mechanism panel.

SLIP - The frequency output obtained from the TRAIN SPEED oscillator simulates the average output of all but one of the axle generators. The frequency output of this one generator is obtained from the oscillator associated with the SLIP SPEED dial, which is set to a value 7 mph. or more above the setting of the TRAIN SPEED dial. The positioning of the AXLE switch determines which axle generator has been used to simulate the "slip" condition. If the mechanism is working properly, a slip indication will result at each of the 6 axle generator positions of the AXLE switch.

CAL. - If a fault is found in either the slide or slip position, the CHECK and AXLE switches are set to CAL. Center position of the meter needle with the switches in the CAL position shows that the test unit itself is working properly and that the indicated fault is not the result of improper operation of the test unit. This position of the switches also connects the train speed oscillator output to all axle generator circuits, so that all electronic a-c. to d-c. converter units should be producing the same voltage output. A high-resistance voltmeter check may then be used to check the output of each channel at the tip-jacks provided for this purpose on the detector chassis. The channel at fault will then be indicated by a voltage reading appreciably different from the other channels.

Potentiometers located below each tip-jack have been included to make corrections of slight voltage variations. If adjustment cannot be secured in this manner, replacement of a tube in the channel at fault will normally restore the unit to working order.

Each of the new instruments will measure approximately 11 x 11 x 8 inches and will weigh less than 20 pounds. The simpler version of the two test units will not have the two adjustable dials of the unit described above, but will use two fixed frequency outputs, the difference of these two frequencies being representative in mph. of a "slip" condition. With this exception, the simplified unit will provide the same test facility as the variable-speed unit.

GENERAL RAILWAY SIGNAL COMPANY

G-R-S NEWS

December 1953

In this issue:

G-R-S WHEEL SLIP AND SLIDE DETECTOR

G-R-S WHEEL SLIP AND SLIDE DETECTOR

A new wheel slip and slide detector has been developed which provides sensitive, reliable detection of slip and slide of Diesel-electric locomotive wheels over a wide range of operating speeds. The equipment is designed to give long periods of continuous service with minimum maintenance. To facilitate routine inspection, a portable test set is available which permits a complete functional test of the apparatus in a few minutes while the locomotive is standing in the terminal or shop.

Wheel Slip Detection and Correction

When installed on 4-axle locomotive units, the system will detect wheel slip equivalent to a speed of 7 m.p.h. over the average speed of all wheels on the unit. When this occurs, the system provides automatic correction, through the locomotive generator control system, by cutting off the generator feeding the traction motor involved. The resulting loss of driving torque permits the slipping wheel to regain traction. As soon as the slip is corrected, the slip-detector circuits return to normal, allowing the generator to pick up the load again as provided by the locomotive control equipment.

The engineman is informed of the wheel slip by the lighting of a warning light while the slip exists. Since correction occurs rapidly, this indication will normally appear as a short flash. The engineman need not "notch back" to stop the slip, thereby reducing output of all units in the locomotive. Instead, the corrective action is confined to one unit, and other locomotive units continue to develop full output. Loss of tractive effort is minimized, both in pounds of force and in time duration. Additional benefits are the protection of traction motors from overspeed damage, reduction of wheel wear caused by wheel slip, and the protection of rail from burns.

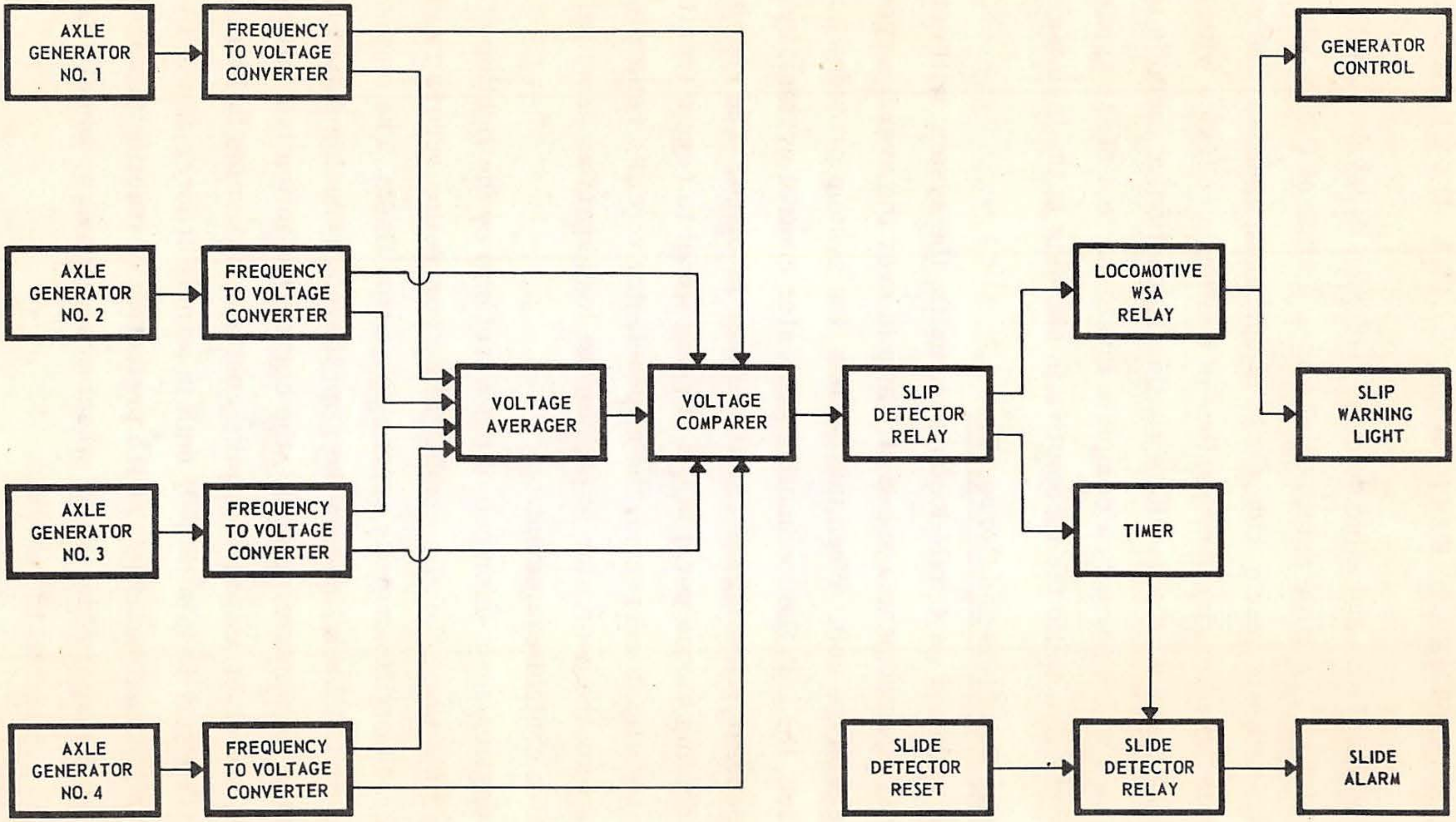

AXLE GENERATOR NO. 1
FREQUENCY TO VOLTAGE CONVERTER
AXLE GENERATOR NO. 2
FREQUENCY TO VOLTAGE CONVERTER
AXLE GENERATOR NO. 3
FREQUENCY TO VOLTAGE CONVERTER
AXLE GENERATOR NO. 4
FREQUENCY TO VOLTAGE CONVERTER
VOLTAGE AVERAGER
VOLTAGE COMPARER
SLIP DETECTOR RELAY
LOCOMOTIVE WSA RELAY
GENERATOR CONTROL
SLIP WARNING LIGHT
TIMER
SLIDE DETECTOR RESET
SLIDE DETECTOR RELAY
SLIDE ALARM

Figure 1. Block diagram, G-R-S wheel slip and slide detector.

Wheel Slide Detection

The same principle used to detect wheel slip also detects wheel slide. In the case of slide, however, the equipment detects that an axle is turning at a speed appreciably lower than the average speed of all axles on the unit. When this occurs, the system responds, as with overspeed slip, by cutting off the output of the traction generator on the locomotive unit involved, and by lighting the warning light in the engineman's cab. Since cutting off traction motor torque normally will not free a sliding wheel, the action here is not a momentary one as with slip correction. Consequently, the slip detection system remains in the "slip" condition.

Each time a slip indication occurs, an associated timing system goes into operation. If the slip indication continues for approximately 15 seconds (an interval considerably greater than that needed for slip correction), the timing circuit energizes a "slide" alarm circuit. An alarm bell then rings in the engineman's cab to warn him of the improper condition. The combination of this alarm bell and the continuously lighted slip warning light indicates to the engineman that a slide condition exists.

When a slide alarm occurs, the engineman handles his locomotive in accordance with individual railroad rules. Normally, he is required to come to a stop, so that the fireman can make a visual inspection of the wheels involved. To facilitate this inspection, the G-R-S slide detector system provides an indication lamp at the equipment case in each locomotive unit. When a slide occurs, this lamp lights on the unit affected, and remains lighted until the detector system is reset. Thus it is easy to locate the unit involved, and the fireman can concentrate his attention on the wheels of that unit. He avoids the time-consuming inspection of wheels on other units which would be necessary without the localization feature provided by the G-R-S slide detector system.

Once a slide is detected, the system keeps power cut off the unit in-

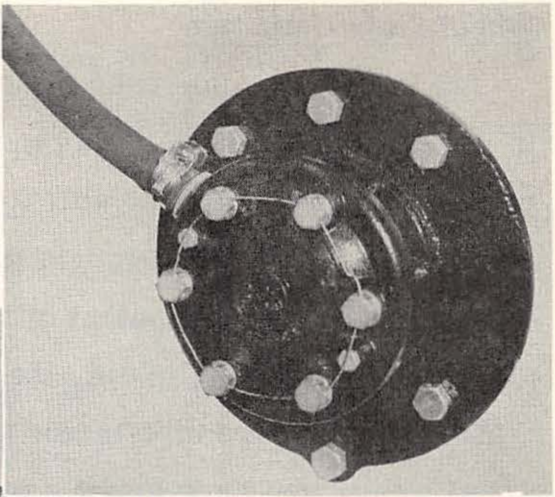


Figure 2. Axle generator.

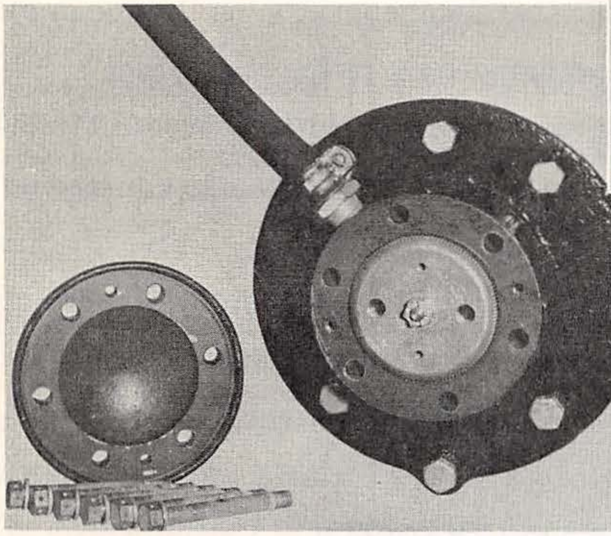


Figure 3. Axle generator cover off.

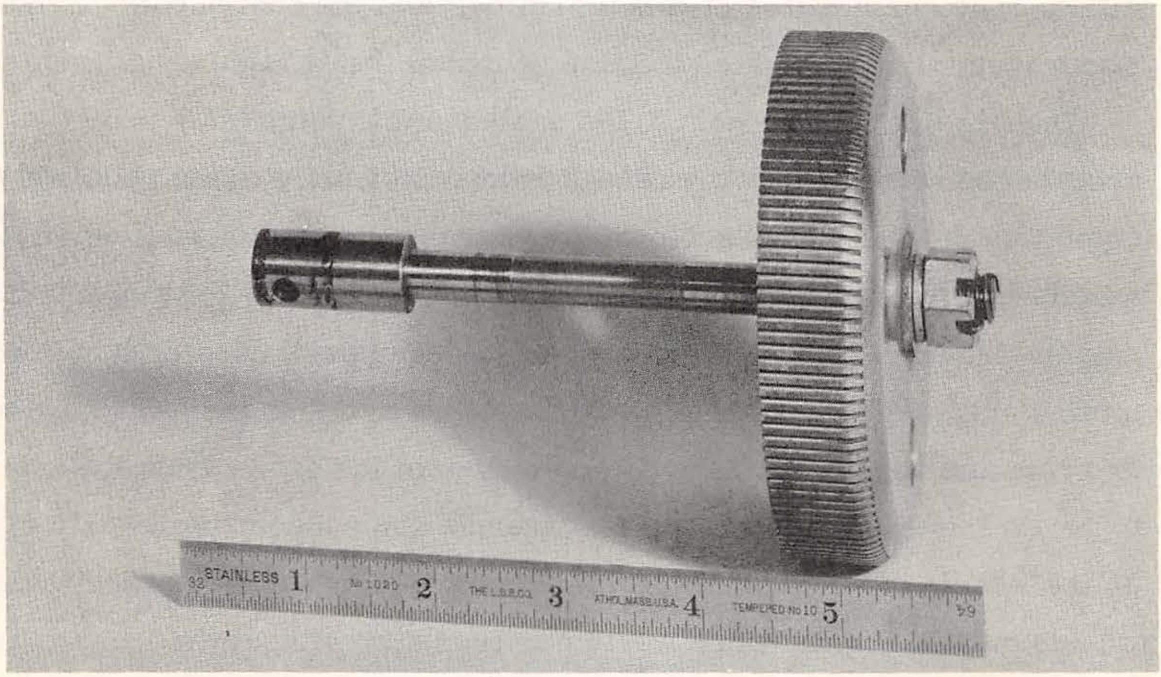

STAINLESS 1
No 1020 2
THE L.S.S.CO. 3
ATHOL,MASS.U.S.A. 4
TEMPERED No 10 5

Figure 4. Rotor for axle generator.

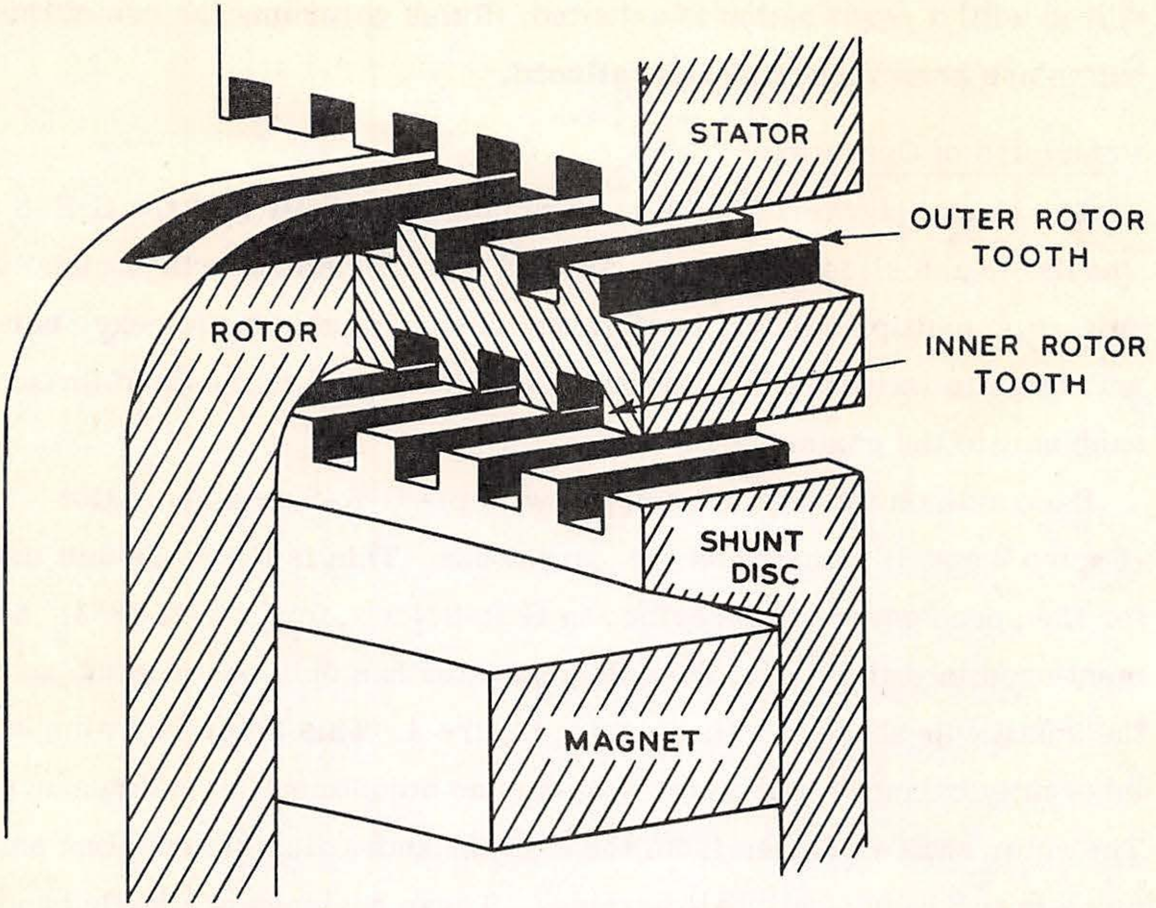
volved until a reset button is actuated. Rules governing the use of this button are prescribed by each railroad.

Principles of Operation

The block diagram, Figure 1, shows the organization of the G-R-S wheel slip and slide detector as applied to a single four-axle locomotive unit. For multipled units, similar equipment is included for each unit, with the slip warning lamp and slide alarm circuits train-lined through each unit to the engineman's cab.

Each axle on the unit is equipped with the G-R-S axle generator (Figure 2 and 3) mounted on the journal box. This is the same unit used for the speed governor described in G-R-S News, for August 1953. As mentioned in that article, the axle generator has only one moving part, the small cup-shaped toothed rotor, Figure 4. This rotor is a simple, inherently balanced unit which requires no adjustment or maintenance. The rotor shaft is driven from the axle through a flexible coupling and turns in two heavy-duty ball bearings. These bearings are sealed and lubricated for life and have load capacities far in excess of those imposed by the rotation of the relatively light rotor. Unlike the typical mechanical speed detecting mechanism, the axle generator uses no contacts, cam, flyweights, springs, push rods, or gears.

The rotor has teeth cut into both the outer and inner rim sections as shown in Figure 5. The rotor teeth are cut in staggered fashion; that is, each outer tooth on the rim is directly opposite a space on the inside of the rim and vice versa. As also shown in Figure 5, the rim of the rotor extends between a stator and shunt disc, both of which are toothed. The teeth of the stator and shunt disc, however, are assembled directly opposite each other. As the rotor turns, an outer tooth on the rotor lines up with a stator tooth and then an inner tooth on the rotor lines up with a shunt disc tooth. This produces changes in the flux path of the


STATOR
OUTER ROTOR TOOTH
ROTOR
INNER ROTOR TOOTH
SHUNT DISC
MAGNET

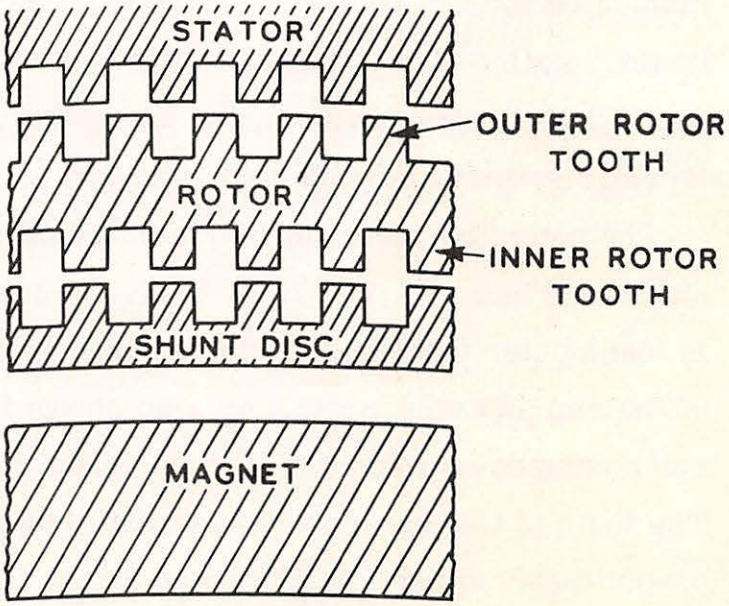

STATOR
OUTER ROTOR TOOTH
ROTOR
INNER ROTOR TOOTH
SHUNT DISC
MAGNET

Figure 5.

(above) Cutaway section shows how toothed rotor rim rotates between teeth on stator and shunt disc.

(right) Supplementary view shows more clearly position of rotor teeth and spaces on stator and shunt disc.

magnet shown below the shunt disc, as will be explained later. Figure 6 shows how the rotor, stator, shunt disc, and magnet are assembled in the axle generator, together with a coil in which the a-c. output is produced.

Figure 7A shows the distribution of magnetic flux through the rotor, stator, and coil when the rotor outer teeth and stator teeth are opposite each other. At this time, the rotor inner teeth are opposite spaces on the shunt disc. In this position the air gap between rotor and stator is at a minimum, while the air gap between the rotor and shunt disc is at a maximum. As a result, practically all the flux flows from the magnet to the rotor, across the small air gap between the rotor outer teeth and the stator teeth, and back through the stator to the magnet, as indicated by the heavy arrows in Figure 7A. Because of the relatively large air gap between the rotor inner teeth and the shunt disc, only a small amount of flux flows from the magnet to the rotor and back through the shunt disc to the magnet, as shown by the dotted arrows.

When the rotor moves one half the distance between adjoining teeth, the rotor outer teeth line up with the spaces on the stator and the rotor inner teeth line up with the teeth on the shunt disc. As a result, the air gap between rotor and stator is at a maximum and the gap between rotor and shunt disc is a minimum. The magnetic flux path is now primarily through the rotor and shunt disc as shown in Figure 7B, with only a small amount of flux passing through the stator. Note, however, that some magnetic flux, although small, is present at all times in both the shunt disc and the stator as indicated by the dotted arrows in Figures 7A and 7B.

Thus the effect produced by rotation of the rotor is a building up and decay of the magnetic flux through the stator. Since the magnetic flux in the stator passes through the coil, a voltage is induced in the coil by the flux changes. The frequency of this alternating voltage is proportional to the speed of the wheels, thus providing the basic information used by the system in detecting wheel slip and slide.

The alternating voltage from each axle generator is fed to the mechanism by a direct wire connection. Since the axle generator output is taken from the stator, no brushes, slip rings, or commutators are required.

The inherently simple structure of the axle generator, combined with rugged mechanical construction, produces a device needing negligible maintenance. At the date of writing, a generator of this type has been in daily road service for over 15 months without requiring maintenance. A number of other axle generators, placed in service more recently, have accumulated over 1,000,000 unit-miles without need of maintenance.

The basic speed information used in the G-R-S slip and slide detector is the a-c. frequency obtained from each axle generator. This frequency, as has been noted, is determined by axle rpm. Variations in generator voltage level caused by speed, aging, temperature changes, etc., do not affect the accuracy of the speed indication, as is the case with voltage - responsive types of speed indicators.

The a-c. frequency from each generator is fed to the wheel slip and slide mechanism for each unit. This mechanism consists of a plug-in electronic chassis and associated power supply, carried in a mechanism case mounted inside the locomotive.

In the mechanism, each a-c. signal is fed to an associated frequency-to-voltage converter circuit as shown in Figure 1. The output of the frequency-to-voltage converter circuits is a d-c. voltage, the value of which is proportional to the a-c. frequency arriving from the axle generator.

Each frequency-to-voltage converter circuit produces two outputs, one fed to the voltage averager, the other to the voltage comparer. The

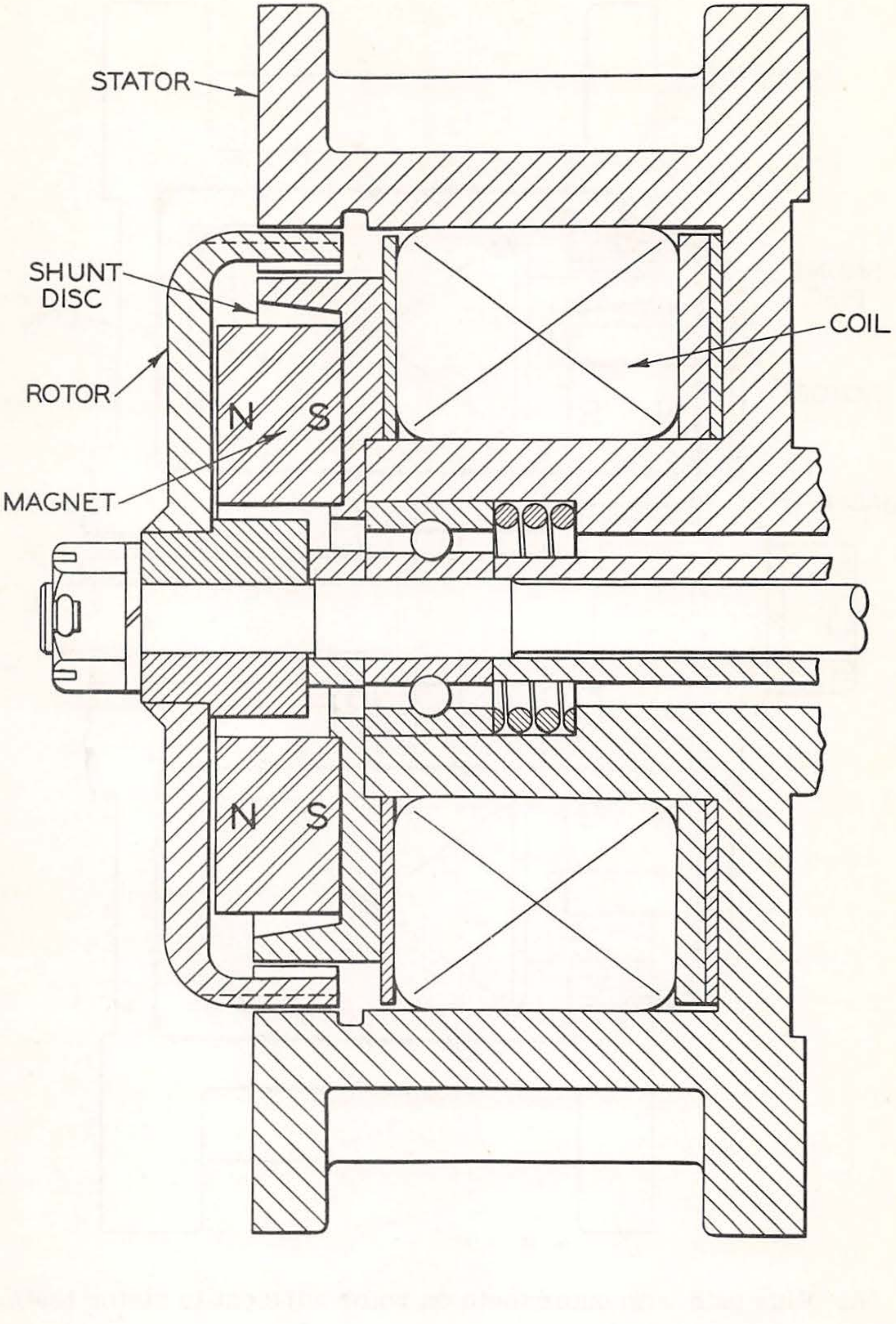
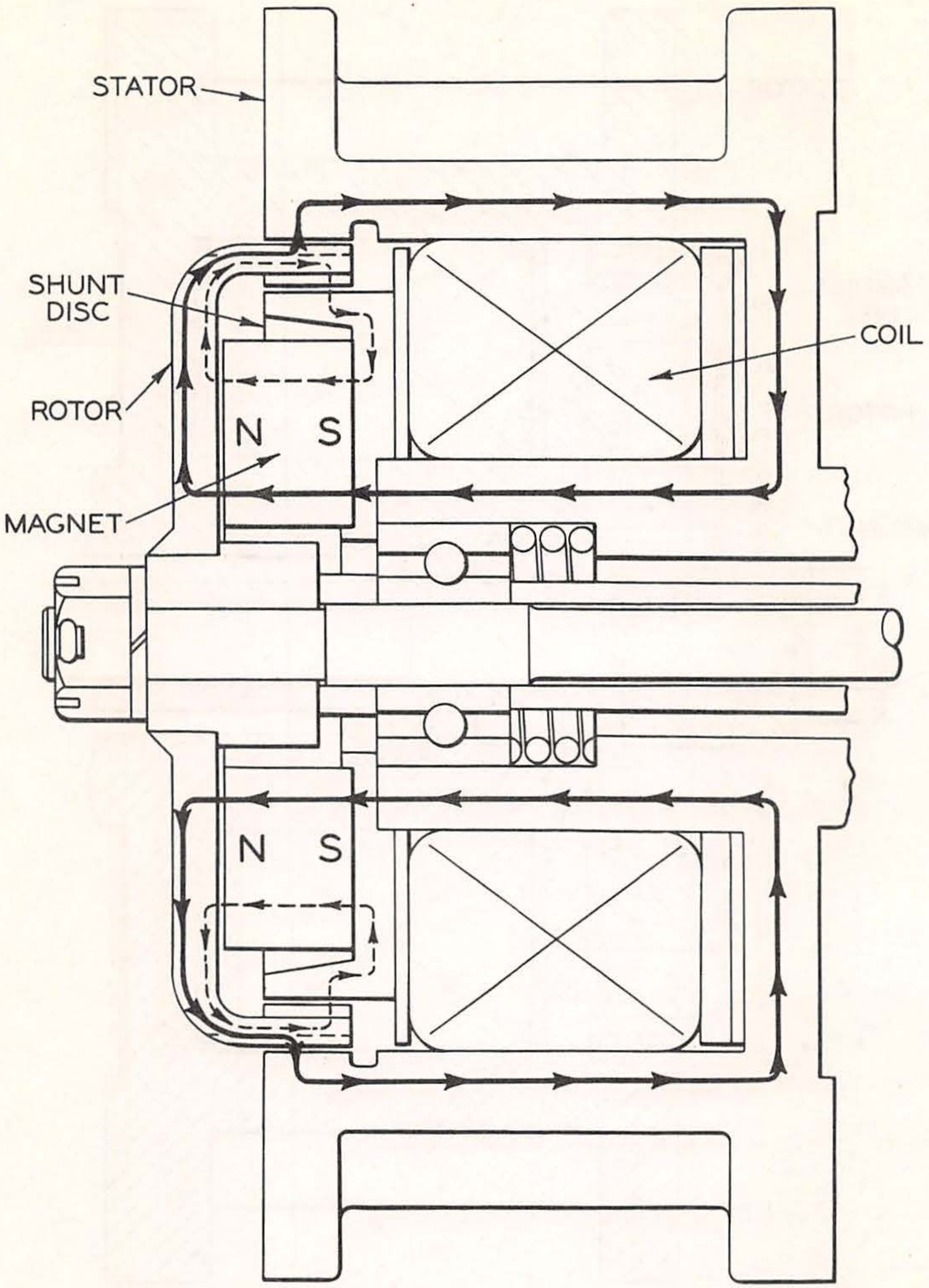
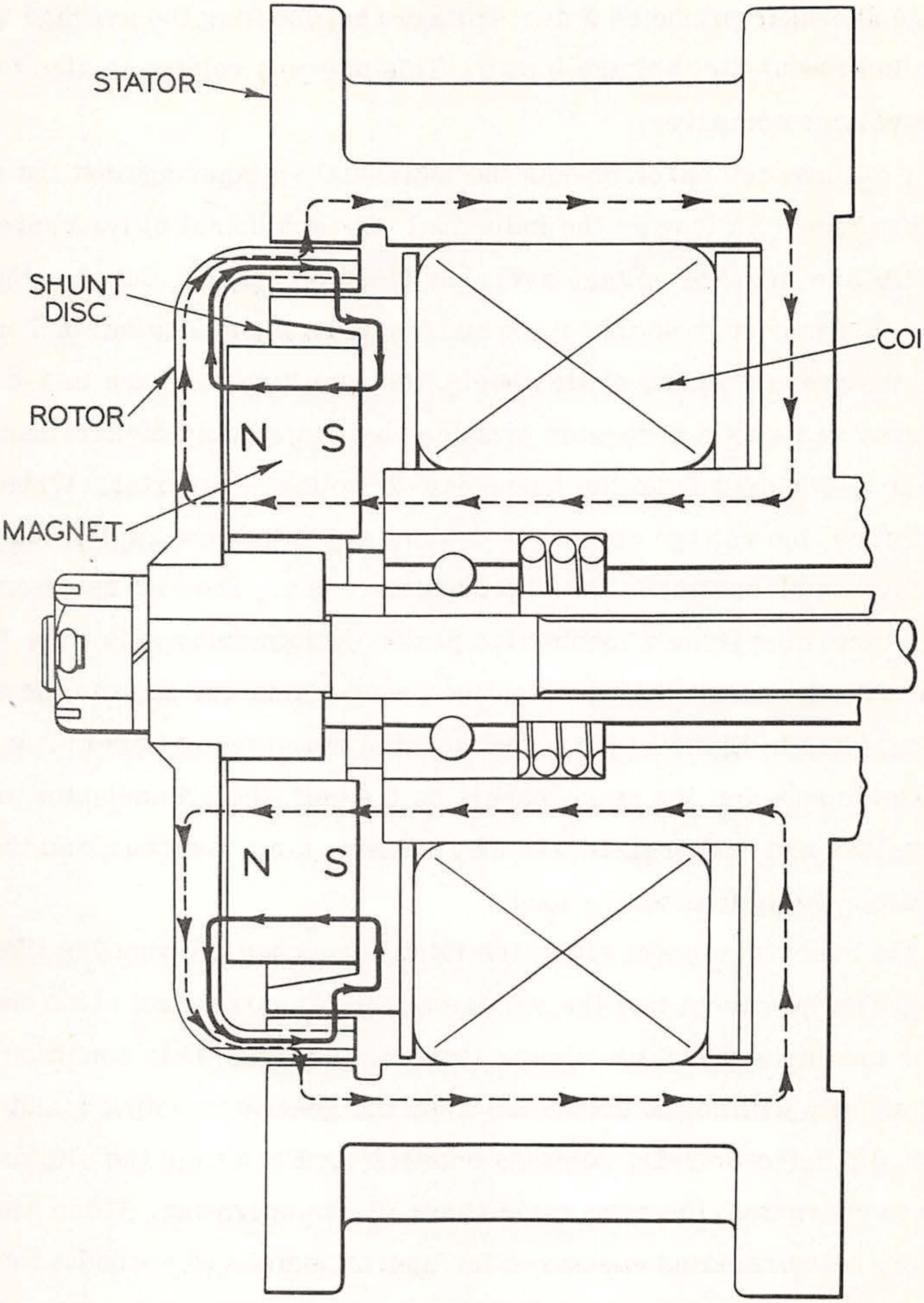

STATOR
SHUNT DISC
ROTOR
MAGNET
N
S
N
S
COIL

Figure 6. Sectional view of axle generator.


STATOR
SHUNT DISC
ROTOR
MAGNET
COIL
N
S
N
S

A. Flux path with outer teeth on rotor adjacent to stator teeth.

Figure 7. Flux paths in axle generator.


STATOR
SHUNT DISC
COIL
ROTOR
N
S
MAGNET
N
S

B. Flux path with inner teeth on rotor adjacent to shunt disc teeth.

voltage averager produces a d-c. voltage representing the average value of the individual d-c. voltage inputs. This average voltage is also fed to the voltage comparer.

The voltage comparer checks the individual voltages against the average voltage. As long as the individual voltages do not differ appreciably from the average, the voltage averager takes no action. But if a wheel begins to slip enough so that its speed becomes the equivalent of 7 mph. above the average speed of all wheels, the resulting increase in a-c. frequency of its axle generator produces an appreciably higher-than-average d-c. output from the frequency-to-voltage converter. When this occurs, the voltage comparer detects the difference, and produces an output which energizes the slip detector relay. The slip detector relay, in turn, energizes a locomotive power system relay called the WSA relay, with the result that the traction generator is cut off, and the slip warning lamp is lighted. When the speed of the slipping wheel drops back to the speed of the other wheels on the unit, the slip detector and WSA relays are deenergized, the slip warning lamp goes out, and the generator again picks up the load.

In the event of a wheel slide, the initial sequency of events is like that for wheel slip, except that the voltage comparer now detects that one axle is turning appreciably slower than the average. This condition, however, usually will not be corrected when the generator output is cut off, so the slip detector relay remains energized. Each time the slip detector relay is energized, the associated timer starts operating. If the slip detector relay remains energized for approximately 15 seconds, the timer circuit energizes the slide detector relay, causing the alarm bell to sound as previously described. Once energized, the slide detector relay remains energized until reset, following rules for reset procedure established by the railroad.

Low Maintenance Requirements

The equipment used in the G-R-S wheel slip and slide detector system has been designed to minimize maintenance requirements. The dependability of the axle generator has already been described. The relays used in the system are G-R-S Type A, whose trouble-free service over millions of operations is well known.

Electronic equipment has been designed specifically for railroad use. Circuit components have generous safety factors in electrical rating, and mechanical design reflects the years of G-R-S experience in supplying locomotive equipment for train control, train stop, and cab signal installations. All vacuum tubes are of the special "ruggedized" types, built for long life under conditions of shock and vibration. The dynamotor used to supply high voltage from the locomotive 64-volt supply is a type which has proved exceptionally trouble-free over an extended period of road operation.

Normal maintenance procedure consists of a complete tube check and visual inspection of electronic units every 3 months and a visual check of axle generators every 6 months. Intermediate operational inspections can be made on a routine basis in a few minutes by using a portable plug-in test set. This test set provides a system voltage check, proves integrity of windings in each axle generator, and checks the response of the system to simulated slip conditions at different speeds.

Equipment changes can be made quickly, with little or no delay to the locomotive. Axle generators are easily replaced by one man in a few minutes without special tools. Electronic equipment is made up of plug-in units, so that units may be quickly exchanged when required.

PATENTS

The Company wishes to congratulate its employees who have had patents issued to them. Copies of these patents will be furnished by the Patent Department upon request made by the inventors involved and those others who may profitably use printed copies of the patents in connection with the Company's work.

Inventor's Name	Pat. No.	Date	Invention
O. S. Field	2,617,846	11/11/52	Type VX relay structure
R. B. Haner	2,617,938	11/11/52	Frequency generator and tester for radio receivers and transmitters
W. M. Barker	2,619,529	11/25/52	A Type K cTc system having alternate route line circuits
N. B. Coley	2,626,314	1/20/53	Syncrostep Type Code Communication System
N. B. Coley	2,626,382	1/20/53	Syncrostep Type Code Communication System Disclosed in a Background of Air Traffic Control System
N. B. Coley	2,626,383	1/20/53	Station Registration in Centralized Traffic Control Systems
H. C. Kendall	2,629,088	2/17/53	An improved form of the Syncropulse System
J. D. Hughson	2,632,844	3/24/53	Automatic Train Control System Having Coded and Non-coded Track Circuit Territories
T. J. Judge	2,635,180	4/14/53	Coded Track Circuit System having the Potential of the Code Pulses Selected in Accordance with the Code Rate

PATENTS (continued)

Inventor's Name	Pat. No.	Date	Invention
J. D. Hughson	2,635,181	4/14/53	Coded Track Circuit with Track Relay Connected to Rails through a Transformer of the Open Ended Type
T. J. Judge	2,635,182	4/14/53	cTc System having Track Obstruction Detecting Means
O. S. Field	2,638,590	5/12/53	Straight Course Locator for Airplanes
C. L. Swanton	2,644,120	6/30/53	Switch Machine Controller Using Polar Biased Electromagnets
N. D. Preston	2,649,536	8/18/53	NX System Controlled from a Keyboard

G-R-S NEWS

August 1953

In this issue:

G-R-S Automatic Retarder Control at Kirk Yard.
Automatic Temperature Controlled Battery Charger.
G-R-S Electronic Speed Governor and
Wheel Slide/Slip Detector.

G-R-S AUTOMATIC RETARDER CONTROL

at Kirk Yard, E. J. & E., Gary, Indiana

Kirk Yard, at Gary, Indiana, for many years a flat switching yard on the Elgin, Joliet and Eastern Railway, is now in full operation as a gravity-retarder classification yard. Completely rebuilt, and equipped with the most efficient equipment available, Kirk Yard represents an investment in modernization of approximately 4-1/2 million dollars.

A unique feature of the new yard is the first field installation of the General Railway Signal Company's automatic retarder control system, applied at the present time to the hump retarder, the north intermediate retarder, and the two northernmost group retarders. This system automatically controls retarders to provide adequate spacing between cuts and to ensure correct release speeds for proper coupling. The system determines a weight class for each cut, then releases the cut at the speed appropriate to its weight class. Speed of the cuts is measured in each retarder by an electronic device which provides continuous and practically instantaneous speed indication. The tower operator has supervisory control over retarders equipped with automatic control, but normally does not have to perform any function, such as operation of levers or pushbuttons, as cars move through these retarders.

In addition to automatic retarder control, Kirk Yard has been equipped with automatic switching for classification tracks, extensive signaling and communications systems, and new lighting equipment. Operations have also been expedited by the construction of adequate auxiliary yards for receiving, departure and local transfer.

It is estimated that the new facilities at Kirk Yard will permit a 20 per cent increase in the number of cars classified per day, using fewer switch engines than formerly required, and that cars will leave the yard

24 to 48 hours sooner than was possible with the old flat switching arrangements.

Kirk Yard, although located near the eastern end of the "J", is an important car classification point for the whole system. Immediately adjacent to Kirk Yard are the United States Steel Corporation's Gary Steel Works, and the American Sheet and Tin Plate Company. Nearby are major plants of the American Bridge Company, the National Tube Company, and the Universal Atlas Cement Company. At Indiana Harbor and Whiting, a few miles west of Gary on the line to South Chicago, are important plants of the Youngstown Sheet and Tube Company, the Inland Steel Company, and the Standard Oil Company, while at South Chicago is another big United States Steel plant. Cars carrying raw materials and supplies into these plants, and into others in the Gary and Calumet districts, and cars carrying out finished products, move through Kirk Yard 24 hours a day. In addition, there is the transfer traffic resulting from the "J" 's many connections.

With the post-war increase in steel plant capacity and production, and with the general growth of industrial activity in the area served, pressure increased on the road's classification facilities. Management, aware of the strong truck competition for outgoing shipments from the mills, and anxious to maintain high standards of service to shippers, made a comprehensive study of traffic flow on the entire system. The outcome was a decision to modernize Kirk Yard, since the studies indicated that improvement of facilities at Kirk would provide maximum benefit to the road as a whole.

In 1950 Kirk Yard was made up of no less than eight separate yards, with a total capacity of about 5,000 cars, in which cars were classified by flat switching. In the course of such classification, it was often necessary for a car to be transferred between yards two or even three times before finally leaving in a train. Moreover, trains departed from five of the eight yards, and frequently required doubling when making up, since few of the yard tracks exceeded 40-car capacity. As a further consequence of the overtaxing of facilities at Kirk Yard, it was also necessary to dispatch trains with cars to be reswitched at other locations on the line.

A plan was adopted which called for converting a large portion of the existing flat yards into an integrated retarder-equipped hump yard, with auxiliary yards for receiving and departure work. As far as practicable, existing yard trackage was to be used in the new arrangement. On this basis, work was begun early in September, 1950.

In July, 1952, the new plant went into full operation. As shown on the accompanying plan, the classification yard runs in a generally east-west direction, with the hump at the eastern end of the layout. Adjacent to the classification yard are four auxiliary yards identified as North, East, South, and West Yards.

The North and South Yards are used primarily as receiving yards. The former, with 8 tracks and 669-car capacity, receives cars from the two lines from South Chicago, which include shipments originating in the United States Steel Corporation's South Chicago Works, and from the many other industrial plants located along these lines. South Yard has a total capacity of 1165 cars, with most of the 14 tracks in this yard capable of holding 90 cars. South Yard is used principally for receiving road trains from the West, but it also handles some trains received from the New York Central for points west of Gary. Incoming trains can be routed to any of the 14 tracks in South Yard by non-interlocked electric switches remotely controlled by levers on the panel of the interlocking

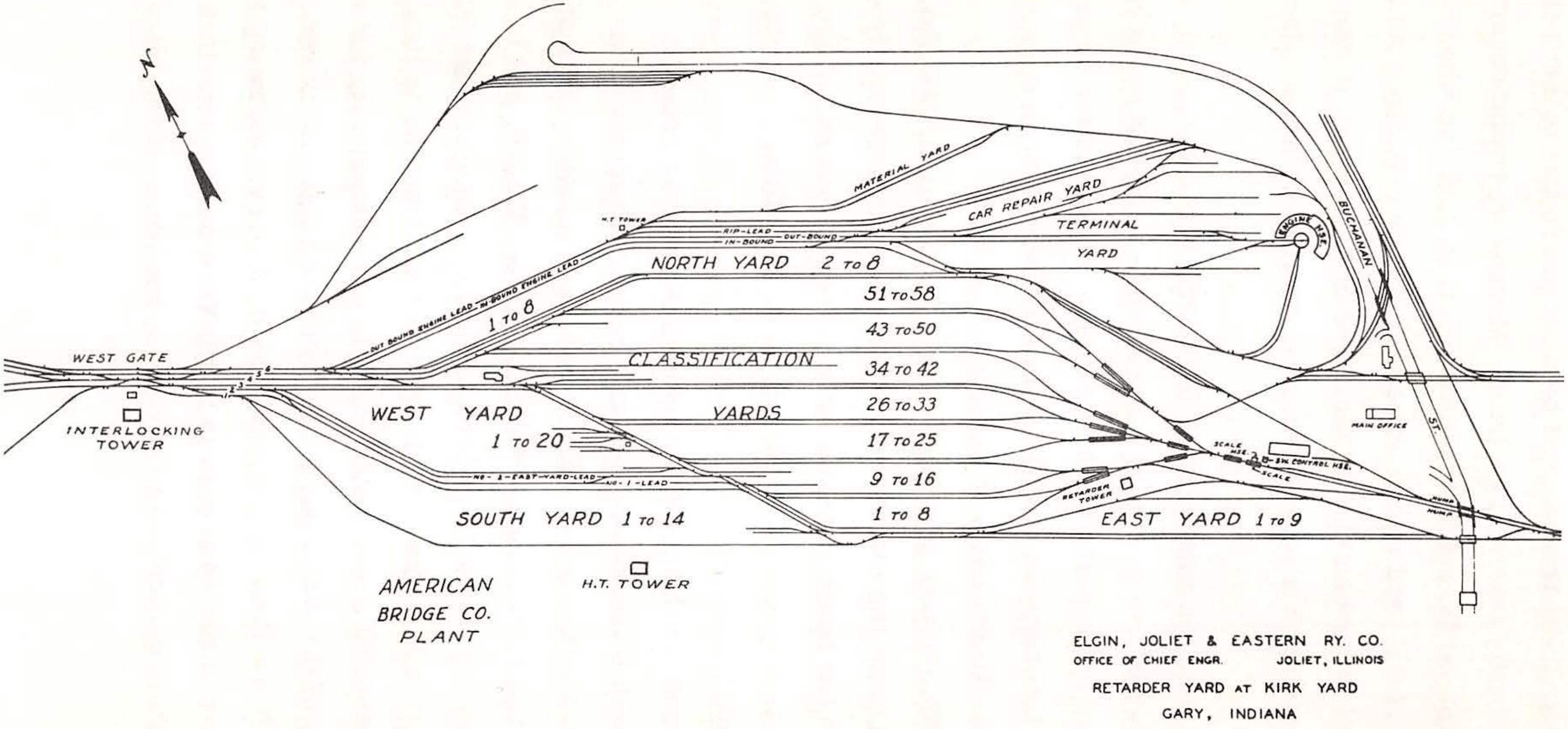

N
MATERIAL YARD
CAR REPAIR YARD
TERMINAL
YARD
ENGINE HSE.
BUCHANAN
ST.
H.T. TOWER
RIP-LEAD
IN-BOUND
OUT-BOUND
OUT BOUND ENGINE LEAD
IN-BOUND ENGINE LEAD
NORTH YARD 2 TO 8
1 TO 8
51 TO 58
43 TO 50
CLASSIFICATION
34 TO 42
26 TO 33
YARDS
17 TO 25
9 TO 16
1 TO 8
WEST GATE
1 2 3 4 5 6
INTERLOCKING
TOWER
WEST YARD
1 TO 20
NO - 2 - EAST - YARD - LEAD
NO - 1 - LEAD
SOUTH YARD 1 TO 14
EAST YARD 1 TO 9
RETARDER TOWER
SCALE HSE.
SW. CONTROL HSE.
SCALE
MAIN OFFICE
HUMP
HUMP
AMERICAN
BRIDGE CO.
PLANT
H.T. TOWER
ELGIN, JOLIET & EASTERN RY. CO.
OFFICE OF CHIEF ENGR. JOLIET, ILLINOIS
RETARDER YARD AT KIRK YARD
GARY, INDIANA

Figure 1. Map of Kirk Yard.

control machine at West Gate. Trains routed to other yards are switched by their crews on the basis of numbers displayed on track indicators at West Gate, controlled from the interlocking tower.

West Yard, which remains essentially unchanged from the original flat yard arrangement, has a capacity of 821 cars on 20 tracks. Although this yard is used chiefly as a departure yard it is also used for handling a certain amount of local industrial traffic, and for transfer movements to roads having connections in the neighborhood, such as the B & O and the PRR. In addition, West Yard handles traffic for local industries other than the steel mills.

East Yard, with 9 tracks and capacity for 197 cars, is actually the remaining portion of a former receiving yard. It is now used chiefly for traffic to local industries lying to the east of the yard, and for miscellaneous car storage.

The classification yard proper occupies the central portion of the area at Kirk Yard, as shown in the diagram. There are 58 classification tracks, ranging in capacity from 32 to 99 cars, with a total capacity of 4187 cars.

The hump is fed by two parallel hump leads which run from the eastern end of the yard toward the hump and which merge into single track about 500 feet east of the crest. Movements up these leads are controlled by two color-light signals at the hump, each with four repeater signals along the approach. Cars to be classified are pulled to the east end of the yard and are then pushed up the slope toward the crest on either of the two hump leads. The provision of two hump leads makes it possible to move a string of cars into position on one lead while another string is being humped from the other lead.

Just beyond the switch at which the two leads merge, the cars pass

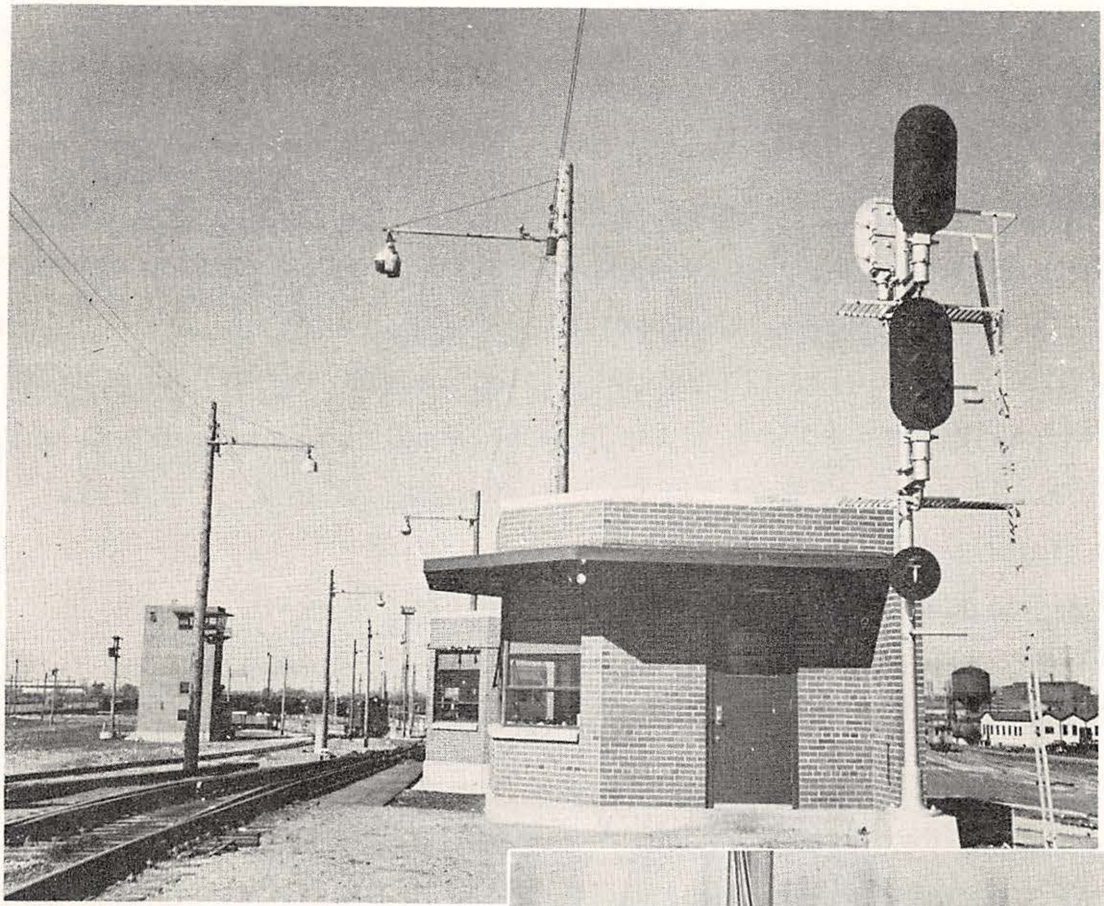


Figure 2 (above). The hump signal is adjacent to the switch control house (hump office). The two type D signals control the two hump leads; the "T" indicator light lower down on the mast is lighted when the trimmer signal (on same mast, facing opposite direction) is cleared.

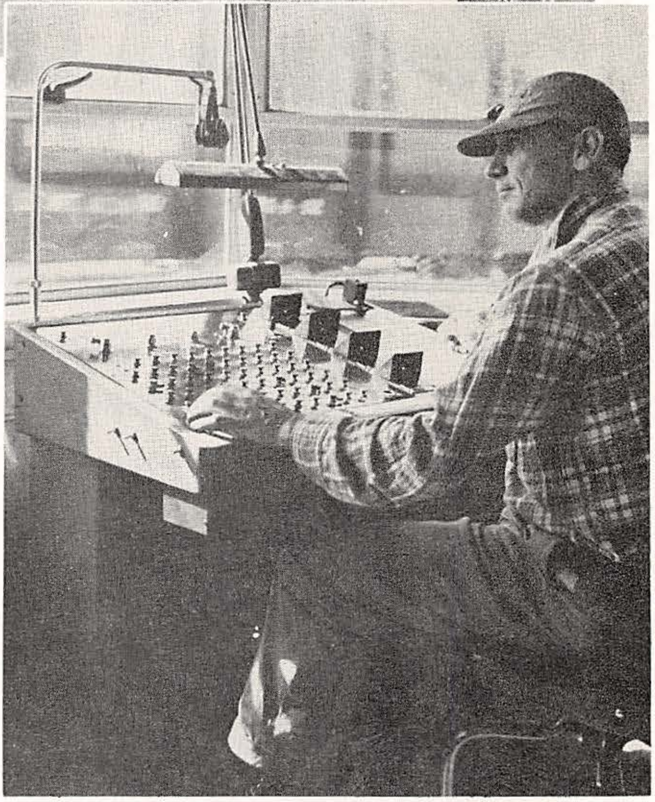


Figure 3 (right). The hump control machine is in the switch control house.

over a dragging equipment detector, and then move between two oiling stations at which journal boxes are lubricated. Next, the cars pass between two inspection pits. These are fitted with large windows at ground level and are equipped with flood lights, shining from the sides and up from the track, so that inspectors have a clear view of the brake rigging and running gear of cars both day and night. A control valve in each pit enables the inspectors to mark bad-order cars with a whitewash spray.

At the apex of the hump the cars pass the switch control house or hump office. The yard foreman is stationed in this building, where he operates the hump control machine. Working from a teletyped switch list, he presses a numbered button on the machine corresponding to the classification track listed for each car or cut of cars. This sets up a route for each cut which is then developed automatically as the car rolls through the switching area of the yard. Each successive switch, operating under control of the automatic switching system, positions itself as required in advance of the cut to route the cars to the desired track. No manual selection of switch positions is required during normal humping operations.

To facilitate the pushbutton routing of cars, the automatic switching system provides storage arrangements for four routes at the hump. That is, a maximum of four track destinations may be fed into the system for cars which have not yet reached the first switch in the classification layout. To indicate to the yard foreman the route storage capacity available at the hump, and to give him a check on the buttons pushed, the hump control machine is equipped with four route storage indicators. As each button is pushed, the button number appears illuminated on the route storage indicator corresponding to the storage position of the route, and then advances from indicator to indicator as the cuts move through the first switch. A dark indicator shows that route storage capacity is available, while the illuminated numbers in the other indicators may be checked against the switch list to verify that the correct buttons have been pushed.

In addition to the route selection buttons and related items, the hump machine is also equipped with signal levers for controlling the hump and trim signals, and with a switch lever for controlling the switches on the scale by-pass track.

As the cars move over the crest of the hump, they are uncoupled by a pin puller, either as single cars, or as cuts of two or more cars. The yard foreman informs the pin puller of the number of cars in each cut by using a loudspeaker mounted outside the switch control house.

Once uncoupled, cars roll down the west side of the hump under the influence of gravity. Immediately below the crest of the hump, the cuts pass over an automatic scale which produces a printed record of the weights for all cars selected for weighing. The scale requires only three seconds to produce this printed record, so that the data is obtained while the cars are rolling at normal speeds.

Following the scale, the cuts pass over the weight detecting unit used in the automatic retarder control system. This is a treadle-actuated device which establishes a weight class for each cut.

Immediately beyond the weight detecting unit the cuts pass through the hump retarder. This retarder, like all others at Kirk Yard, is a G-R-S Type E retarder. The hump and group retarders are 99-foot units, each with two operating mechanisms; the intermediate retarders are 49.5-foot units with single mechanisms.

In the hump retarder the cuts are retarded as required, and then released at the proper speed for the weight class. This is accomplished

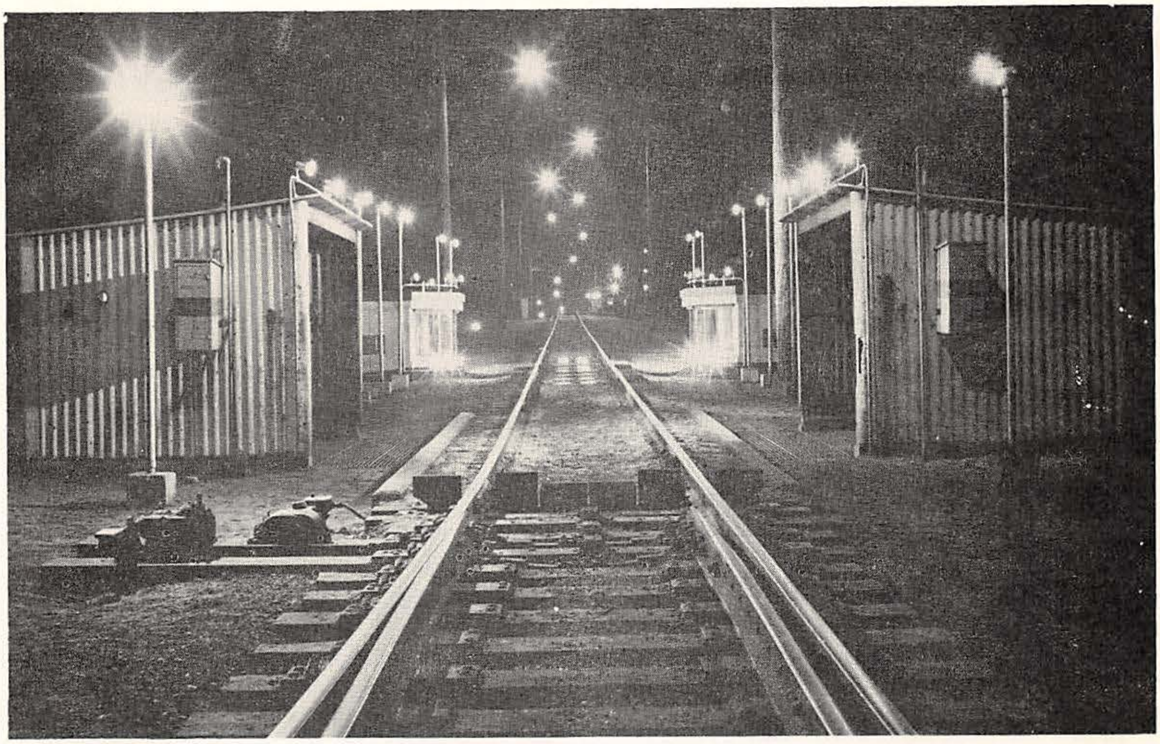


Figure 4. Night operations are facilitated by a modern lighting system. G-R-S self-restoring dragging equipment detector is just beyond switch at junction of the two hump leads.

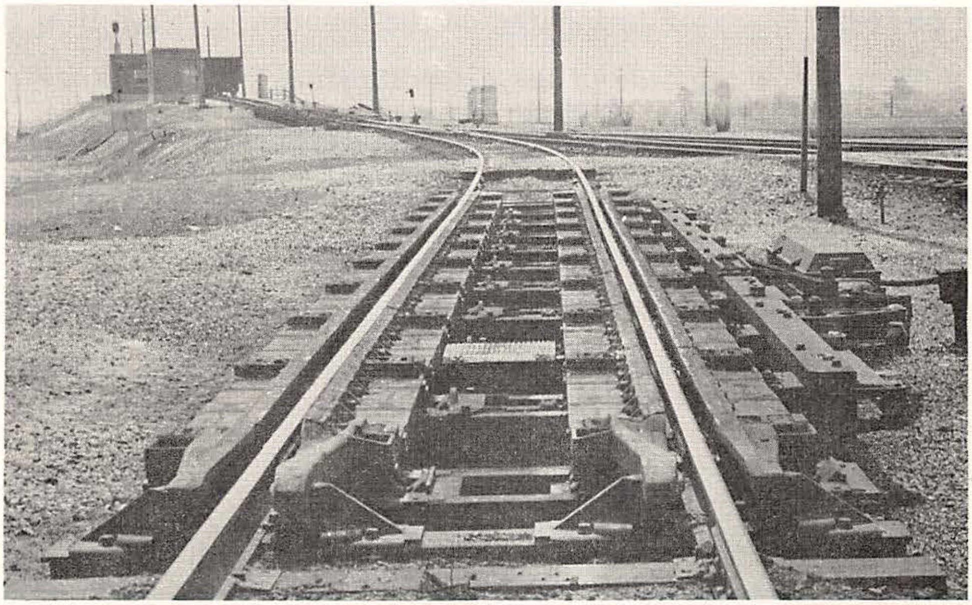


Figure 5. All retarders at Kirk Yard are G-R-S Type E. Intermediate retarder here is 49.5 feet long, with single mechanism. Hump and group retarders are 99 ft. long with two mechanisms.

by the automatic retarder control system previously mentioned.

After leaving the hump retarder, the cuts move over a lap switch, and then on to one of the three intermediate retarders. From the intermediate retarders the cuts proceed through another set of switches which route them to the proper track groups for the selected classification tracks, after which they enter the group retarders.

There are seven 99-foot group retarders, five handling groups of eight tracks each, and two handling nine tracks each. The five group retarders for tracks 1 to 42, with the two intermediate retarders preceding them, are at present manually controlled by the retarder operator. The operator watches the cuts intended for these groups as they roll from the hump, and he controls these retarders so that the cars remain properly spaced and so that they move onto the classification tracks at proper coupling speed.

Normally, the retarder operator need pay no attention to the hump retarder, since this retarder is automatically controlled.

The retarder operator is located on the fourth floor of a new 50-foot tower built on the south side of the classification layout. Large windows on three sides give the operator an unobstructed view of all retarders, enabling him to follow the progress of a cut from the hump until it is well down on its classification track. Floodlights on steel towers in the yard, and pole-mounted overhead lights along the hump and through the switching area permit operations to proceed as smoothly by night as by day.

The retarder control machine is a "T" shaped unit with the classification yard track layout engraved on its panels. Controls for switches and retarders are mounted on this diagram in the same relative positions that the corresponding functions occupy in the yard. During humping, the switch controls are positioned so that the switches function auto-

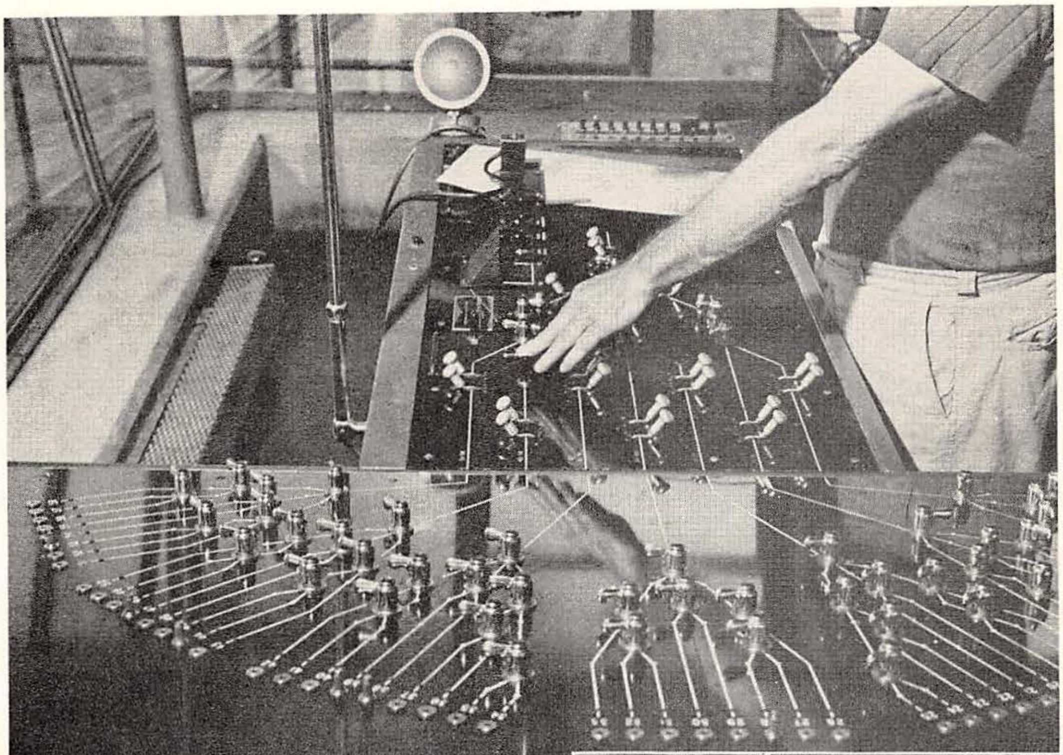


Figure 6a (above). Modifying lever for group retarder enables retarder operator to make moderate change, slower or faster, in automatic release speed of group retarder.

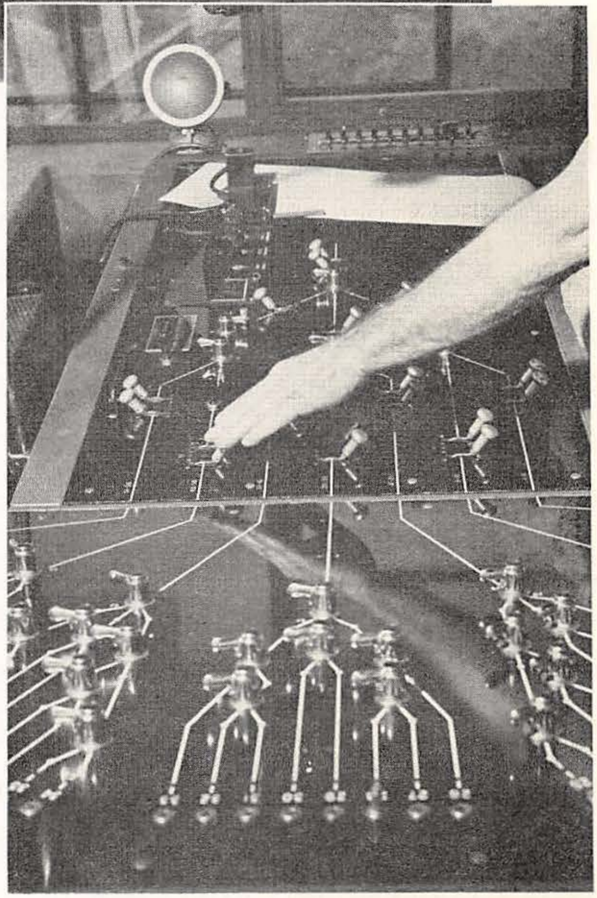


Figure 6b (right). Manual control of automatic retarders is obtained by moving levers to manual position.

matically. For other operations, such as trimming, the operator may position the switches as required to line up desired routes.

There is a retarder control lever for each retarder mechanism in the yard. Each of the levers has an H (heavy), L (light) and O (open) position. In addition, the levers for the retarders equipped for automatic control have an A (automatic) position.

For the manually controlled retarders, the operator selects for each cut either the H or L position of the retarders through which the cut will pass, basing his decision on experience and on his knowledge of the weight of the car as given on the switching list. When, in his opinion, the cut has been sufficiently slowed, he moves the retarder control lever to O, and releases the cut.

For the hump retarder, and for the automatically controlled intermediate retarder, the retarder operator normally leaves the control levers in the A (automatic) position, and allows the system to assume full responsibility for release speeds. For each of the two automatically controlled group retarders, however, the control machine is equipped with speed modifying levers, in addition to the retarder control levers. These permit the retarder operator to make a moderate adjustment, slower or faster, in the release speed of the group retarders when, in his judgment, such modification is desirable. For example, if a car is moving to a track which is nearly full, so that distance to coupling is short, the operator may decide that the automatic release speed is higher than necessary, and operate the modifying lever to obtain a reduced release speed. On the other hand, in the case of a hard rolling car moving onto a nearby empty track, he may decide to use the speed modification in the opposite way to obtain a higher than normal release speed so that the car will roll well down the track.

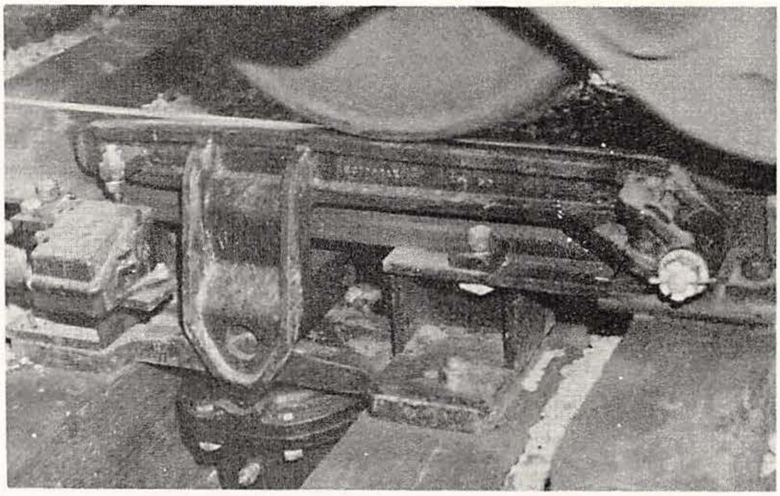
In addition to the modifying control which he has for the automatic group retarders, the operator may at any time assume conventional manual control of any of the automatic retarders (hump, intermediate, or group) by simply moving the associated retarder control lever from the "A" (automatic) position to any of the manual control positions.

The automatic retarder control system now in service at Kirk Yard includes a number of innovations in the field of retarder control. It is the first fully automatic system in the sense that, under normal conditions, the cuts roll from hump to classification track and are retarded as required without requiring any action on the part of the retarder operator. The release speed for each cut is selected by the system on the basis of the weight class of the cut, and release is obtained automatically at this speed. It is also possible to include curve compensation in the automatic release speed, so that cars bound for tracks with more curvature in the route are released at a higher speed than those with less curvature.

The weight detecting unit which establishes a weight class for each cut is located on one rail immediately ahead of the hump retarder. It is a relatively simple device made up of a treadle, a spring and dashpot assembly, and a circuit controller. The wheels of each cut move over the treadle, depressing the treadle against the spring proportionally to the wheel weights. When the treadle is depressed by car wheels passing over it, contacts are closed in the circuit controller. Circuits are thus established in the system which determine a weight classification for the cut as light, medium, or heavy. The release speeds applied to each cut are then selected by the system to fit the weight classification, fastest for the "light" cuts, intermediate for the "medium" cuts, and slowest for the "heavy" cuts.

In the present Kirk Yard installation the weight class for each cut is established by the weight detecting unit at the hump, and is then trans-

Figure 7 (right). The weight detector unit is just ahead of the hump retarder.



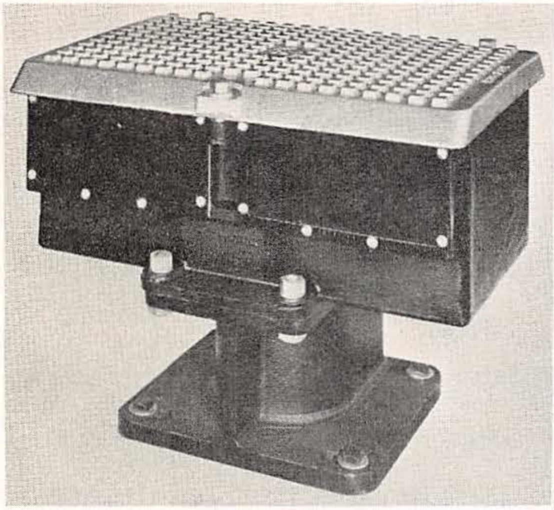


Figure 8a (left). Speed detector unit.

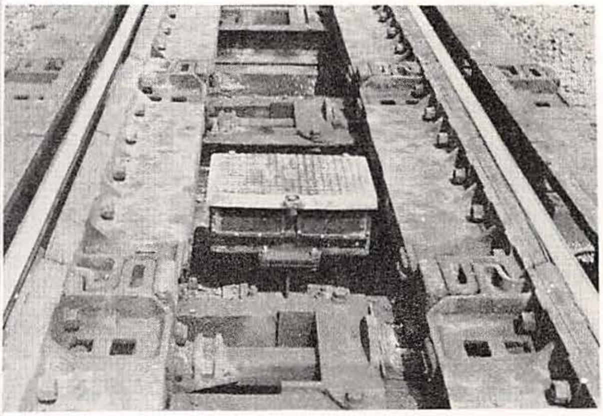


Figure 8b (above). Speed detector is mounted between rails, near leaving end of retarder.

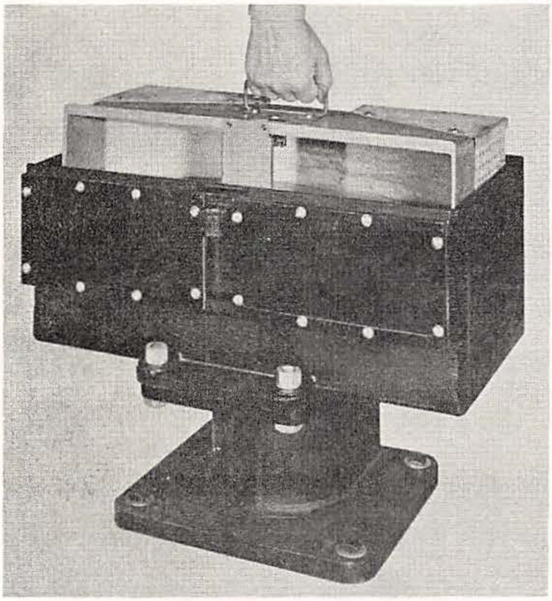


Figure 9 (left). Electronic chassis in speed detector is plug-connected, easily removed.

ferred by relays to the other retarders in the route in a manner similar to that used for transferring route codes in the automatic switching system.

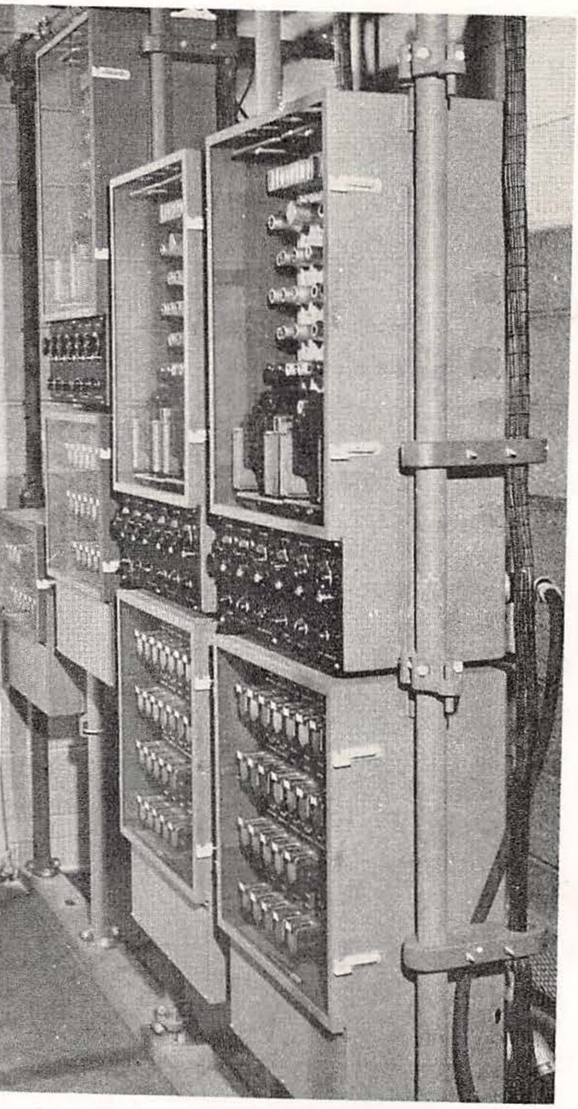
In order for the automatic retarder system to function, information must be available as to the actual speed of the cuts as they move through the retarders, so that the retarders can be released when the cut has been properly slowed. This is provided by speed measuring devices at each retarder which provide a continuous and essentially instantaneous indication of speed as the cuts move through the retarders.

The speed measuring units are located in the retarders, between the rails, about 8 feet ahead of the leaving end of each retarder section. Two-unit retarders have two speed detectors, one associated with each retarder mechanism.

The speed measuring device consists of an electronic chassis mounted in a heavy metal protective housing about 22 inches wide, by 16 inches deep (front to back) by 10 inches high. This housing is supported on a cast iron pedestal which rests, in turn, on a concrete footing. The structure of the speed unit is entirely independent of the retarder structure. The electronic chassis is a plug-in unit, easily removed from and replaced in the protective housing.

In operation, the electronic unit emits untrahigh-frequency radiation in a narrow beam aimed at a low angle up through the retarder. As a car moves into the retarder, some of this radiation is reflected back to the electronic unit from the axles and other parts of the car structure. If the car is moving, the waves reflected from the car are changed in frequency by an amount proportional to the speed of the car. This is an example of the Doppler effect, more familiar to us in the apparent change in pitch (frequency) of a locomotive whistle as it passes, or in the apparent

Figure 10 (right). Discriminator and relay units in retarder tower receive weight and speed data, control retarders accordingly.



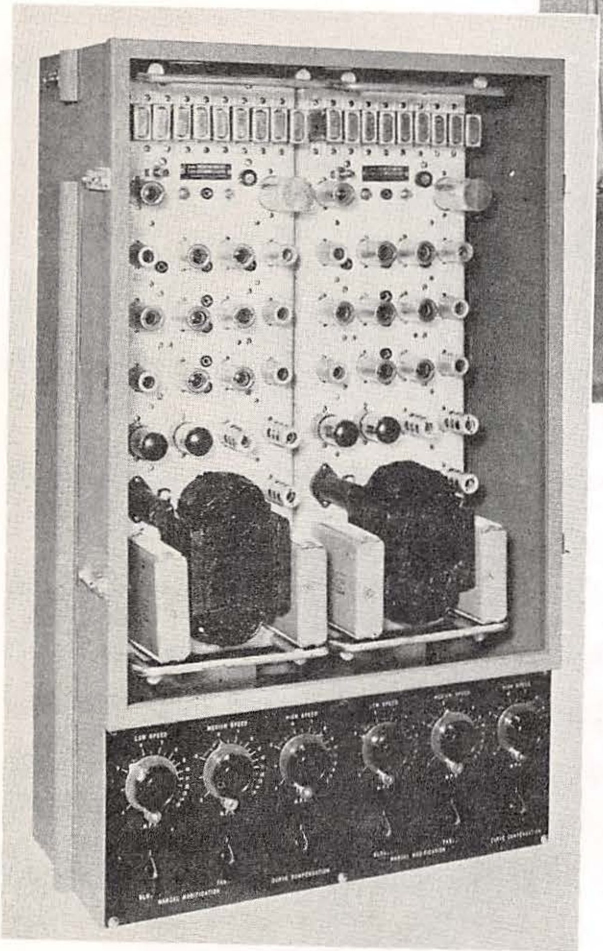

LOW SPEED
MEDIUM SPEED
HIGH SPEED
LOW SPEED
MEDIUM SPEED
HIGH SPEED
MANUAL MODIFICATION
CURVE COMPENSATION
MANUAL MODIFICATION
CURVE COMPENSATION

Figure 11 (left). Discriminator provides relay control output based on speed signal supplied by speed detector unit at retarder. Note controls for setting release speeds.

change of pitch of a grade crossing bell as we approach and pass it in a train.

Some of the reflected radiation is picked up by the speed measuring unit, which compares the original and reflected waves and produces an output proportional to the speed of the cars moving through the retarder. This output is fed from the speed unit to the retarder control equipment in the relay room of the retarder tower. By suitable circuits, this speed information is combined with the weight information obtained from the weight detector unit, to provide automatic retarder release when the cut has been slowed to the speed appropriate for its weight class.

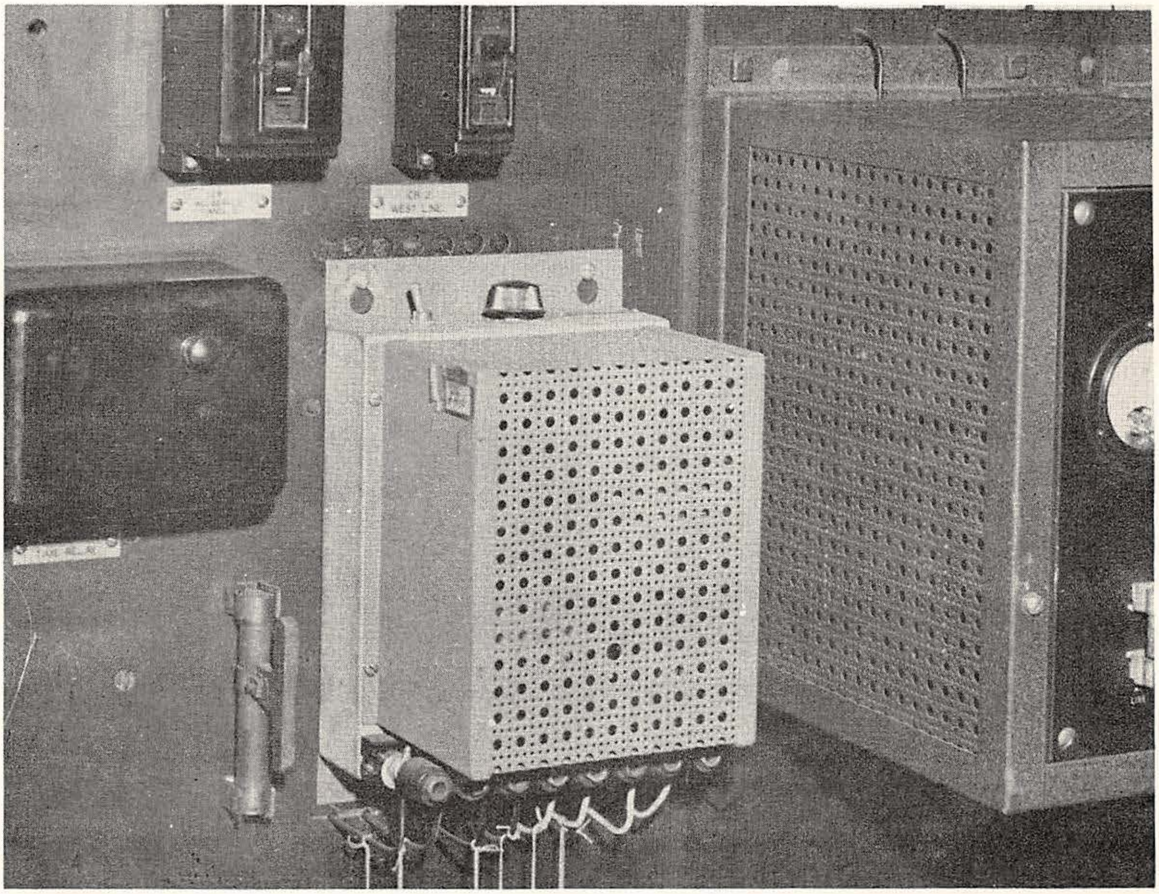
AUTOMATIC TEMPERATURE CONTROLLED BATTERY CHARGER

The General Railway Signal Company is prepared to furnish battery chargers which automatically compensate for temperature.

The purpose of the charger is to maintain a fully charged battery in accord with the cell temperature without overcharging.

The capacity of a lead storage battery decreases as the temperature of the electrolyte falls. Moreover the internal resistance of the cells rises. If the battery is required to deliver a very high current for the few seconds when the battery is very cold, the drop in voltage will be excessive.

Battery manufacturers recommend that the voltage of lead cells be



Temperature-compensated battery charger.

increased with a drop in battery temperature: for example, at 70° F the cell voltage should be maintained at 2.15 volts; at 0° F the voltage should be 2.4 volts. The increased voltage in cold weather offsets to a large extent the affect of increased internal resistance.

The charger is electronically controlled. A resistance which varies considerably with temperature change is attached to the glass battery case, and detects changes in the temperature of the battery. The charger automatically controls the charging rate, tapering the charge when the battery voltage approaches the proper value.

A unit of this type has been in service for several years under extreme changes in battery temperature and has given excellent results. The circuit operation of the charger is described fully in A. A. R. Signal Section Advance Notice Volume XLV No. 1, September 1948, pages 345-347.

G-R-S FREQUENCY-RESPONSIVE SPEED GOVERNOR

The FR (frequency-responsive) speed governor, originally described in September, 1951, G-R-S News has been simplified in design, and governors of the revised design have been successfully tested in road service.

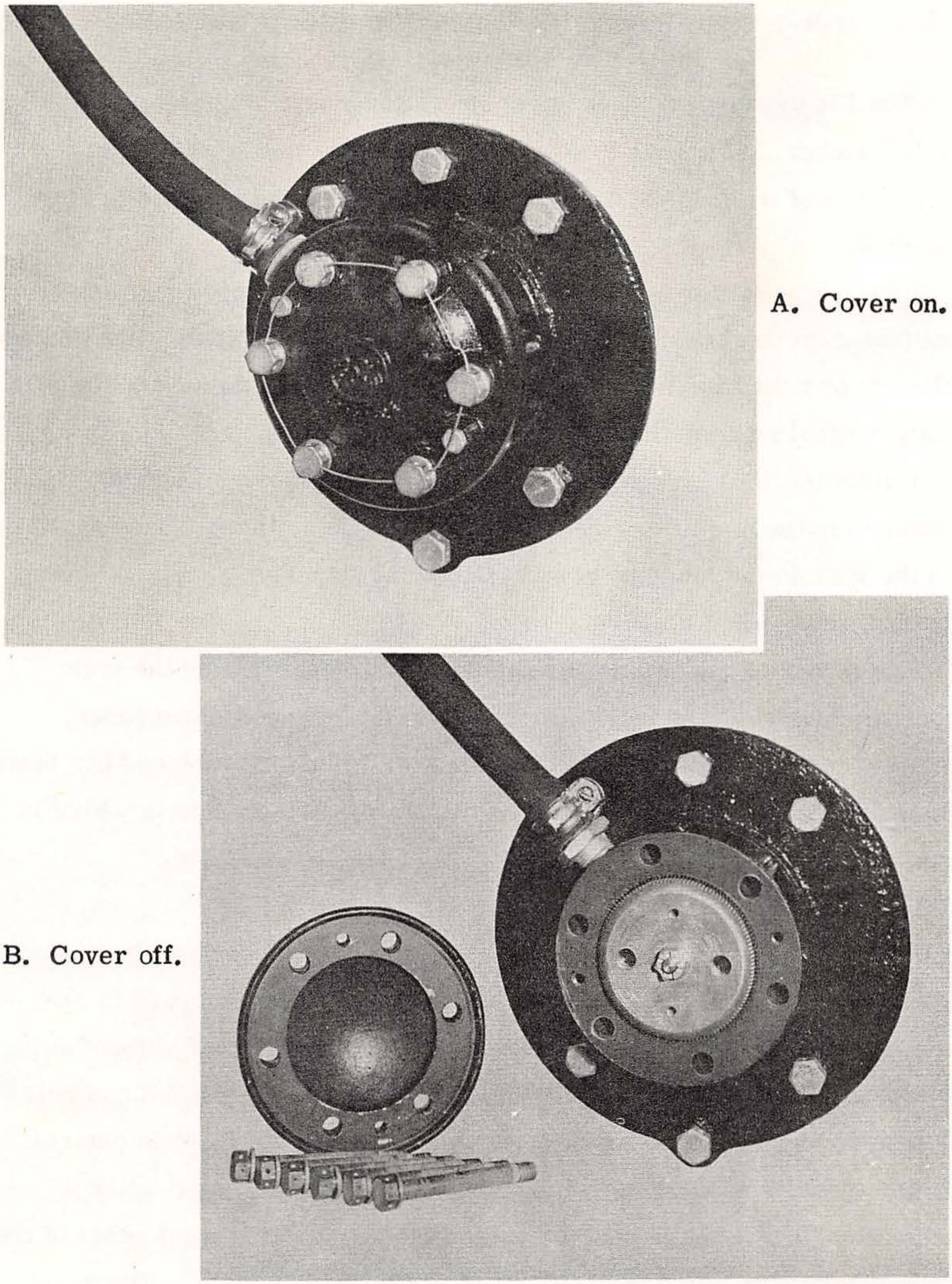
The new governor is intended for locomotives equipped with intermittent inductive train control, and utilizes the brake application devices already provided for train control. It may also be used with continuous train control systems in place of mechanical governors.

Unlike the 1951 design, which required a dynamotor to furnish high voltage for the amplifier, the new unit works on voltage already available on the locomotive, and needs no auxiliary high voltage supply. Current drain is less than 1 ampere.

The governor controls maximum speed by deenergizing the train control electro-pneumatic valve when maximum speed is exceeded, thereby causing a service brake application. When train speed has been reduced below the permitted maximum, the electro-pneumatic valve is automatically reenergized, and the brakes may be released.

The system provides a speed warning whistle which sounds intermittently when train speed is within three miles per hour of the permissible maximum, and sounds steadily when maximum speed in exceeded. The preliminary intermittent warning is obtained without using any relays in addition to those already needed for over-speed control.

The governor is also used to enforce the intermittent train control system penalty if the engineman passes a restrictive signal without acknowledging. This is done by having the governor prevent reset of the train control system until train speed has been reduced to a low value. The result is an automatically enforced penalty stop.



A. Cover on.

B. Cover off.

Figure 13. Axle generator for FR governor.

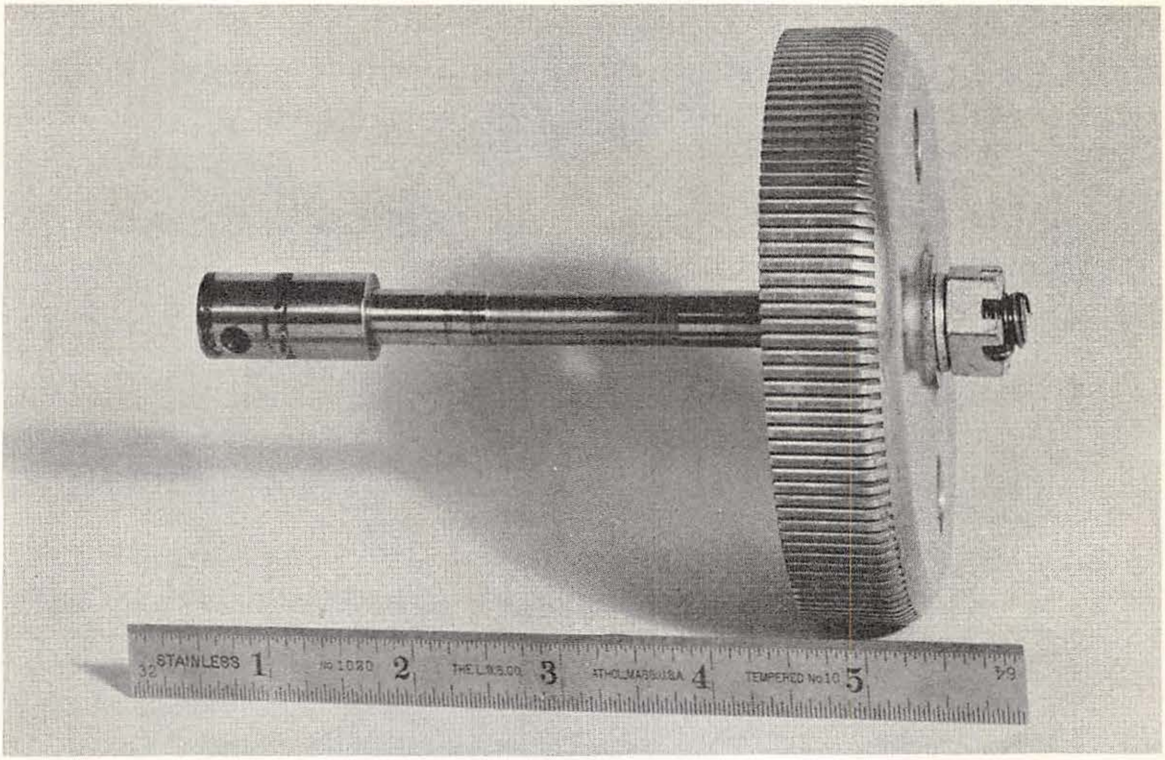


Figure 14. Rotor for axle generator.

Design Features

The FR governor is designed for dependable operation with minimum maintenance. The governor is made up of two basic units, an axle-driven generator (Figures 13, 14) mounted on the journal box, and a mechanism (Figure 15) carried in any convenient location on the locomotive.

The axle-driven generator has only one moving part, the small cup-shaped, toothed rotor shown in Figure 14. This is a simple, inherently balanced unit which requires no adjustment or maintenance. The rotor shaft is driven by a flexible coupling from the axle, and turns in two heavy-duty ball bearings, sealed and lubricated for life, with capacity far in excess of the loads imposed by the rotation of the relatively light rotor. Unlike the typical mechanical governor, no flyweights, cams, springs, push rods, or gears are involved.

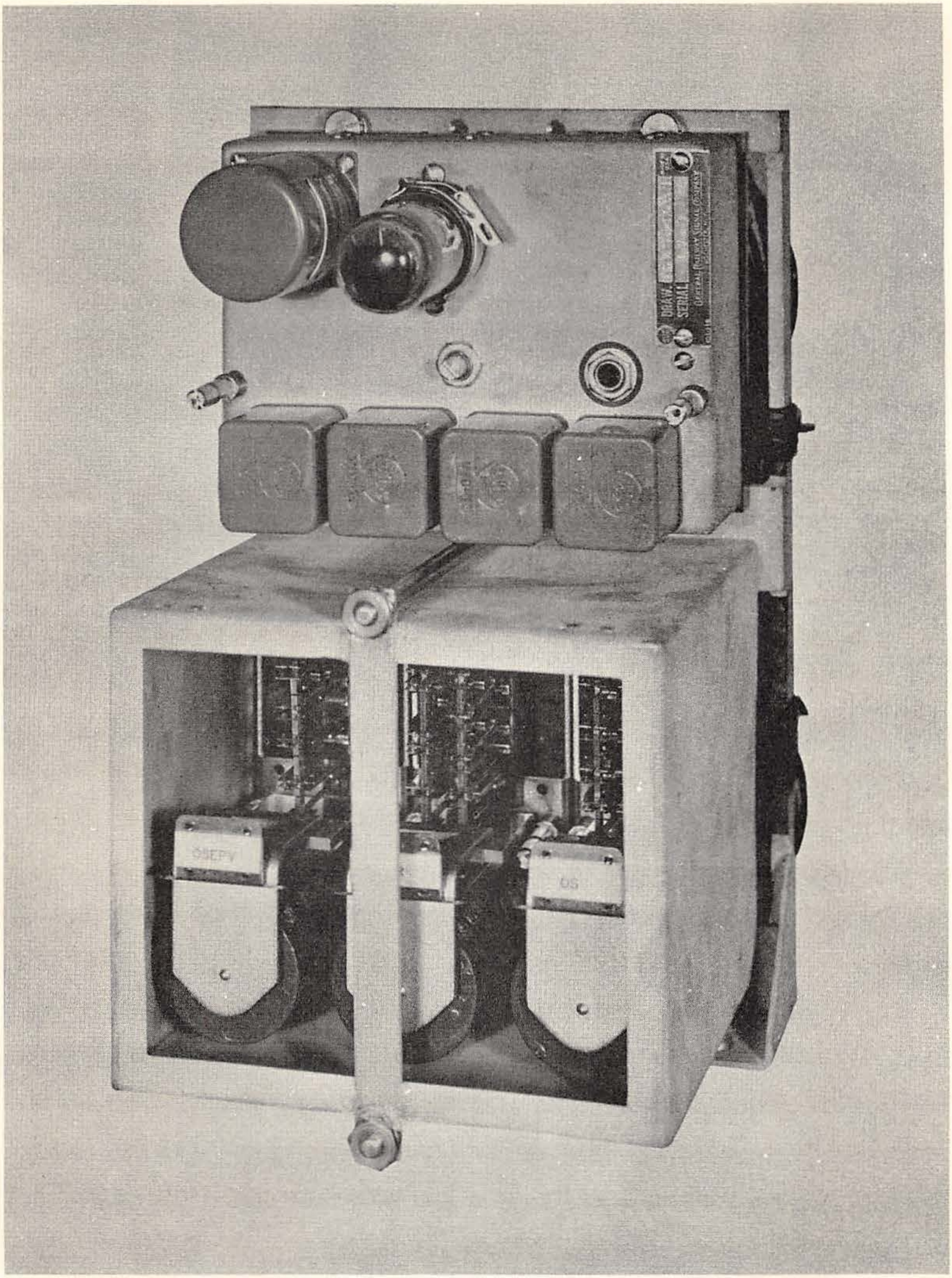


Figure 15. Mechanism for FR speed governor (developmental model, subject to change).

The toothed rotor spins in a permanent magnet field, causing an alternating voltage to appear in stator windings. The frequency of this alternating voltage depends upon axle rpm, and hence upon train speed. The actual voltage level, on the other hand, remains substantially constant with speed because of circuit design. It does, of course, decrease to zero as the train comes to a stop.

Alternating voltage from the generator is fed to the mechanism over a pair of wires. The mechanism is mounted in a mechanism case which may be carried inside or outside the locomotive body. If it is mounted outside, a weatherproof case is used.

The mechanism for use with an intermittent inductive train control system uses a vacuum-tube amplifilter (amplifier-filter) and three Type A relays. Mechanisms used with continuous train control systems require an additional relay for each intermediate speed limit, but require no additional vacuum tubes. The amplifilter chassis, like the relays, is plug connected and is easily maintained.

The self-checking feature of the governor described in G-R-S News of September 1951 has not been included in the new design. With this one exception, the new design provides all the features of the older design, with a considerable simplification of circuits and apparatus. An over-all summary of these features follows.

1. Axle-driven generator is a simple assembly of rotor and stator housed in a compact case. No flyweights, springs, gears, or cams are used. Since output is obtained from a stator winding, there are no slip rings, commutators, or brushes.
2. System is frequency responsive. Output frequency of the generator is determined by the rpm of the axle. Variations in output voltage caused by speed, temperature changes, aging, etc., do not affect performance.

3. Amplifier operates directly from existing locomotive energy, requires no auxiliary power equipment.
4. Basic system provides over-speed control and train control penalty enforcement. By adding a passive filter unit and relay for each additional speed limit, the governor may be used with multiple-limit speed control systems. No additional vacuum tubes are required.
5. A single over-speed contact, the front contact of a Type A relay, is used to enforce all speed limits, including the varying limits required in multi-speed systems. This relay is mounted in the mechanism case on the locomotive. There are no contacts in the axle generator.
6. The governor may be set to enforce passenger-train maximum speed or freight-train maximum speed by operation of a toggle switch.
7. Wheel wear adjustment is made by means of a multiple-position switch in the mechanism case. No mechanical adjustment is required.
8. The governor may be tested by injecting a suitable electrical test signal into the system. It is not necessary to provide mechanical rotation of the generator, nor to uncouple it from the axle. The vacuum tube in the amplifilter may be tested while in place in its socket.
9. Equipment is compact, easy to install. Relays and amplifilter are plug connected. Axle generator is a relatively small light-weight unit which one man can easily mount on journal box without requiring hoists or similar devices.

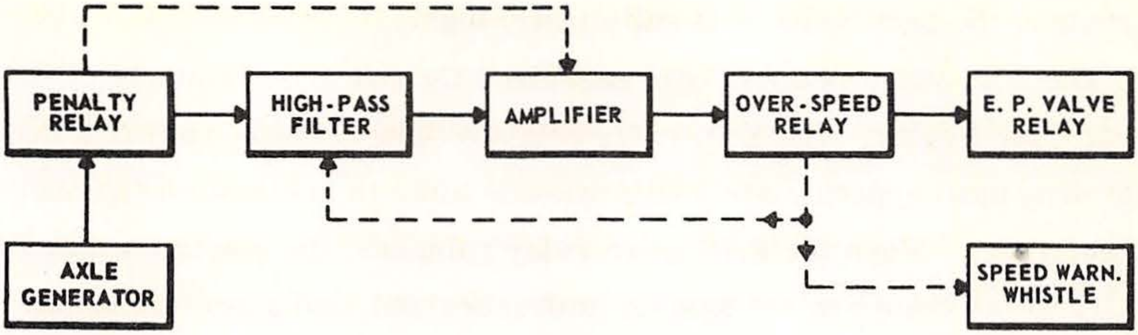


Figure 16. Block diagram, FR governor.

Principle of Operation

The organization of the FR governor is illustrated in the block diagram, Figure 16.

As mentioned previously, the axle generator generates a-c. voltages with frequencies proportional to locomotive speed. Under normal conditions, the a-c. output from the axle generator is fed through front contacts of the penalty relay to the high-pass filter.

The high-pass filter blocks a-c. voltages with frequencies lower than a pre-determined cut-off frequency, but passes voltages with frequencies higher than this value. The cut-off frequency under normal conditions corresponds to the axle-generator frequency when speed is three miles below the permissible maximum. In this case we shall assume for purposes of explanation that the maximum permissible speed is 80 miles an hour, and that the high-pass filter cuts off at the frequency corresponding to 77 miles per hour. Other values of maximum speed may, of course, be used.

The amplifier operates to hold the over-speed relay energized when no appreciable a-c. input voltage is fed to the amplifier. When an appreciable a-c. voltage is fed to the amplifier, the over-speed relay is de-energized and releases. The amplifier responds in this way not only to high-frequency inputs, but also to inputs of relatively low frequency, provided the input voltage is sufficiently high.

The E.P. valve relay is held energized through front contacts of the over-speed relay. The E.P. valve relay is slow release, so that it does not drop until approximately five seconds after the release of the over-speed relay. When the E.P. valve relay releases, the electro-pneumatic valve in the train control system is deenergized, and a service brake application occurs.

In the example we have chosen, when train speed does not exceed 77 miles per hour, the output of the axle generator is too low in frequency to pass through the high-pass filter. As a result, the amplifier holds the over-speed relay energized, and control of the train remains with the engineman.

If train speed increases to between 77 and 80 miles per hour, the axle-generator frequency is passed by the high-pass filter to the amplifier, and the over-speed relay releases. The release of the over-speed relay has two effects, indicated by the dashed lines in Figure 16 drawn from the bottom of the over-speed relay block: (1) it causes a speed warning whistle to sound; (2) it changes the characteristics of the high-pass filter so that the cut-off is increased to the frequency corresponding to 80 mph. Because of the increased cut-off frequency, the a-c. input from the axle generator to the amplifier is again blocked, and the over-speed relay is reenergized and picks up. This silences the whistle and restores the 77 mph. cut-off value of the high-pass filter. If train speed continues between 77 and 80 mph., the cycle repeats, with the over-speed relay alternately releasing and picking up, thereby producing a series of short blasts on the warning whistle.

The E.P. valve relay, however, remains energized while the over-speed relay is cycling up and down. This is because the over-speed relay cycles about once a second, while the E.P. valve relay is slow-release with approximately five-second delay. Hence the over-speed relay does not stay down long enough to release the E.P. valve relay.

If train speed continues to increase until it exceeds 80 mph., the axle-generator frequency will be above filter cut-off even when the over-speed relay is released. As a result, a-c. voltage will reach the amplifier continuously, and the over-speed relay will remain down. Should this occur, the E.P. valve relay will release when the over-speed relay has been down about five seconds, and a service brake application will ensue. The warning whistle will also sound continuously while the over-speed relay is down.

When train speed has been reduced to the range between 80 and 77 miles per hour, the over-speed relay starts to cycle again, the warning whistle sounds intermittently instead of continuously, and the E.P. valve relay picks up, reenergizing the electro-pneumatic valve. With the electro-pneumatic valve reenergized, the brakes may be released.

In actual practice, because the air brake system applies the brakes more quickly than they can be released, an over-speed brake application will reduce train speed substantially below the permissible maximum before release is effective. Knowing this, the engineman will normally reduce speed at the first intermittent warning whistle to avoid the possibility of an automatic brake application.

Penalty Enforcement

The penalty relay indicated in Figure 16 is used with the intermittent train control system to enforce a stop if the engineman fails to acknowledge a restrictive signal.

When the engineman fails to acknowledge a restrictive signal, the train control system deenergizes the electro-pneumatic valve to cause a service brake application which cannot be released until the train control system is reset. Simultaneously, the penalty relay is deenergized.

The penalty relay, when released, transfers the output of the axle generator from the high-pass filter directly to the amplifier, as indicated by the dashed line in Figure 16. As a result, the amplifier receives an appreciable a-c. input even at moderate speeds, causing the over-speed relay to release. The over-speed relay then remains down until the voltage from the axle generator has dropped to a value too low to affect the amplifier. This occurs at about 6 mph. When speed falls below this value, the over-speed relay picks up.

The reset circuits of the train control system are connected through the over-speed relay contacts so that reset cannot be obtained unless the over-speed relay is picked up. Under penalty conditions, this means that reset cannot be obtained until train speed has been reduced to approximately 6 mph. This arrangement automatically enforces a penalty stop, since the train will be completely stopped before brake release can be effective.

Resetting the train control system reenergizes the penalty relay, restoring the governor system to its normal condition.

August 1953

PATENTS

The Company wishes to congratulate its employees who have had patents issued to them. Copies of these patents will be furnished by the Patent Department upon request made by the inventors involved and those others who may profitably use printed copies of the patents in connection with the Company's work.

Inventor's Name	Pat. No.	Date	Invention
F. S. Craig	2,597,707	5-20-52	An improved locking structure for signal covers
O. S. Field & S. N. Wight	2,597,784	5-20-52	Air traffic signaling system
O. S. Field	2,597,785	5-20-52	Model 10 switch machine
N. D. Preston	2,597,818	5-20-52	Train to wayside train communication system
G. J. Johanek	2,604,581	7-22-52	Control circuit for Model 6 switch machine
T. J. Judge	2,605,390	7-29-52	Broken down joint protection for coded track circuits
N. D. Preston	2,605,391	7-29-52	Coded track signaling system with normally deenergized track circuits that are approach started
O. S. Field & S. N. Wight	2,609,684	9-9-52	A contact making altimeter for air traffic control
R. W. Hewes	2,613,329	10-7-52	A contact making altimeter with a thyratron control circuit
W. L. Livingston	2,615,124	10-21-52	Switch machine control and indication circuits using biased polar relays
T. J. Judge	2,617,014	11-4-52	Coded track circuit signaling system having improved directional stick relay

G-R-S NEWS

July 1953

In this issue:

G-R-S Type K2 Flasher Relay.

G-R-S Type K2 cTc System.

G-R-S Line Power Supply for cTc Systems.

New Rotary Switch for G-R-S Control Machines.

G-R-S Clamp Bases for Six-Inch Pipe.

Patents.

G-R-S TYPE K2 FLASHER RELAY

A Type K Size 2 flasher relay has been developed for controlling flashing aspects of block signals.

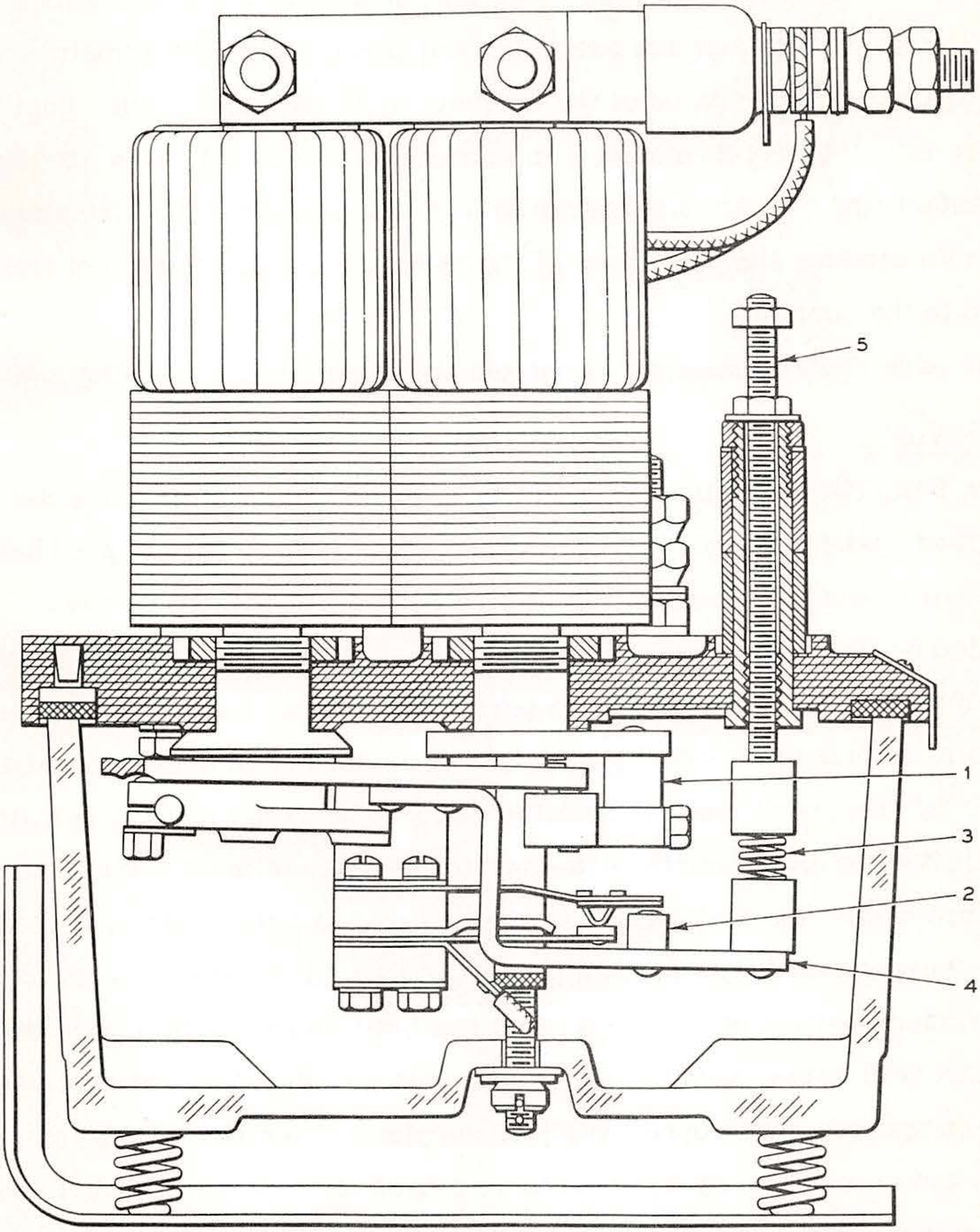


Figure 1. Type K2 flasher relay.

How It's Constructed

The two coils, Figure 1, connected in series, are energized through the back contact in space 2. Permanent magnet 1 is mounted on the underside of the front core face. The magnetic flux, which has a path from the magnet through the armature and cores, holds the armature down against the pole piece of the magnet. With the relay in this position, contact actuating bar 2, mounted on armature extension 4, does not touch the contact fingers. During operation, any oscillations of the armature, due to its striking the pole piece of the permanent magnet, are not transmitted to the contacts.

The back contact in space 1 controls the energy to the flashing signal.

How It Works

The simplified operating diagram in Figure 2A shows the relay deenergized. When the coils are energized, Figure 2B, a flux is produced in the cores which is in opposition to the permanent magnet flux but retarded because of the copper washers. As the coil flux gradually builds up, it overcomes the flux from the permanent magnet thus causing the armature to pick up. With the armature up, the back contact is opened, Figure 2C, removing energy from the coils. The armature will remain up until the flux in the cores dies down to the release level. When the armature drops, the coil circuit is again closed and the cycle is repeated.

The purpose of the permanent magnet is to hold the armature in the deenergized position until the coil flux has built up to a point where the armature will carry through to the front stop pin after the coil circuit has been opened. The copper washers supplement the time delay on pickup and on release so that a suitable on and off time will be obtained to provide a satisfactory flashing signal aspect.

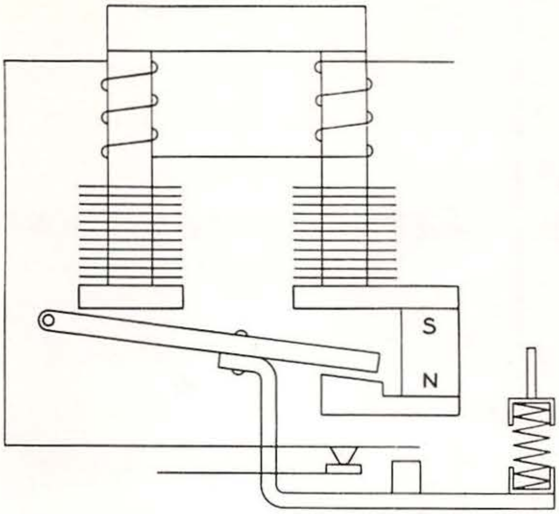


Figure 2A. Armature down - no energy applied.

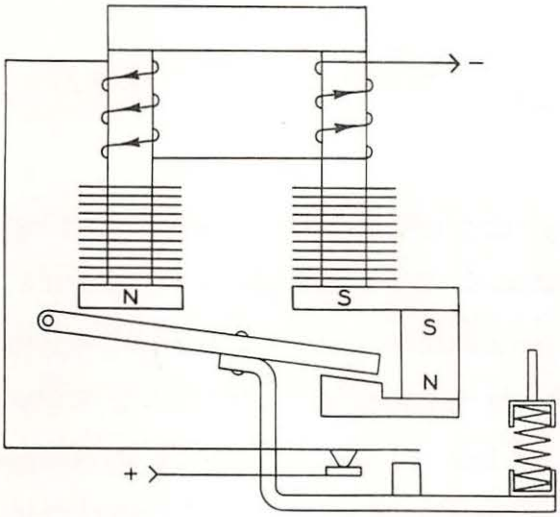


Figure 2B. Armature down - energy applied.

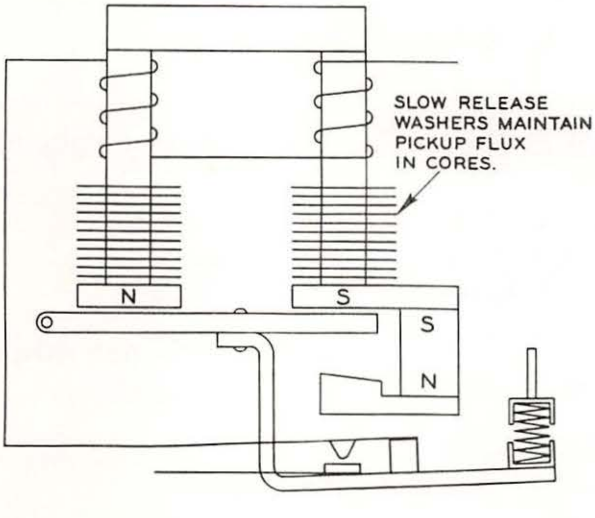

SLOW RELEASE WASHERS MAINTAIN PICKUP FLUX IN CORES.
N
S
S
N

Figure 2C. Armature picked up-energy cut off.

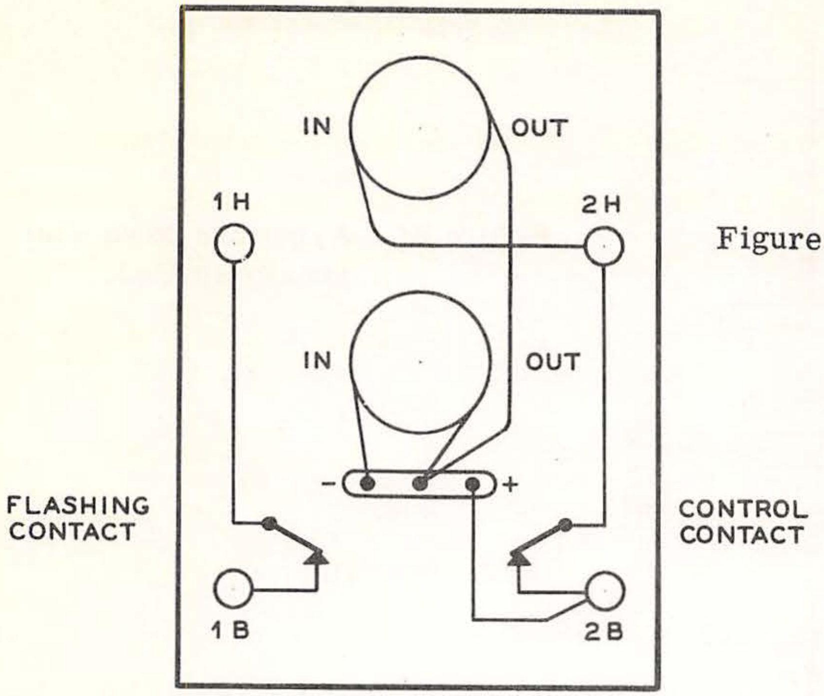


Figure 3. Wiring of type K2 flasher relay.

Rate of Flashing

The rate of flashing is controlled by varying the pressure exerted by spring 3, Figure 1, on armature extension 4. The greater the pressure, the higher the pickup value of the flux generated by the coils and the longer the time of dwell in both the energized and deenergized positions, hence a slower rate of flashing. The pressure of spring 3 is controlled by screw 5 which is turned clockwise to decrease the flashing rate and counterclockwise to increase the rate.

Operating Data

Wiring for the K2 flasher is shown in Figure 3. The operating data for the relay is as follows:

Relay Resistance Ohms	Operating Voltage	Flashing Rate
586	10	50 to 65 per min.

Ordering Information

Type K Size 2 flasher relay	53000-285 Gr. 62

G-R-S TYPE K2 cTc SYSTEM

The newly developed Type K2 system has the following new features as compared with our earlier Types K and K1 (the only improvement of the K1 over the K is the use of the Type VX relay for the line relays): —

1. Increased number of controls and indications per station for the same size system.
2. Unlike the K and K1 systems, which usually use decoding and execution of controls, the K2 system is readily adaptable to progressive delivery, that is, the controls are delivered step by step as the cycle progresses.
3. The standard size is size 8, with or without progressive delivery. A size 10 is available if greater capacity is required.
4. Reliability of the progressive-delivery system is checked. The first four digits of a control code always contain a long and short odd, and a long and short even digit. This is to check that the office is capable of generating any type of digit that may be used later in the cycle. Likewise, the reception of the digits is checked at the field location. Therefore if digits of the proper length are incapable of being transmitted or received, the field location will not be selected.
5. System still retains the ability of decoding, when required, using fewer relays than previously.
6. Has facilities for transmitting single or paired digits. The K and K1 could transmit only paired digits.
7. The EE and EO indication busses are eliminated in the field application circuits.
8. Operates over a wider range of local battery (19 volts to 29 volts).

9. Line energy can be supplied through a voltage-regulating electronic power supply to obtain greater distance with a given wire size. This power supply unit can be used with previous systems but was not available before.
10. Drive-down feature at the end of an energized period provides quicker release of field line relays.
11. Field stepper units provide positive or negative energy for operating the function control relays directly.

G-R-S LINE POWER SUPPLY FOR cTc SYSTEMS

This is an electronic power supply unit that replaces the line battery and has distinct advantages on large cTc systems or where long lines are required. This unit provides a regulated power supply the same as an overcompounded d-c. generator in that the voltage rises as the current demand is increased. It can be preset to limit the maximum possible current to values considerably less than with battery. The maximum current can be limited to any value between 100 and 180 milliamperes. The maximum value of voltage is 180 volts. The unit is 15-1/4 in. long, 8-1/2 in wide, and 9-1/2 in high, and can be installed in a 15-in. end section of a control machine.

The cTc systems to date have employed a battery for line energy. This source has some disadvantages, particularly on long lines. In a shunt type cTc system, such as the K,K1, or K2, a series limiting resistance is used to prevent the current from becoming excessive when the line is shunted near the office to produce coding. Therefore the line battery must be larger than otherwise necessary to offset the voltage drop across the resistance when the line is normal or unshunted. Furthermore, the use of this resistance results in poor voltage regulation, which diminishes the differential current that operates the control office line relay. Differential current is the difference in current between shunted and unshunted line conditions.

As a hypothetical example of operation with a battery line supply, assume 100 volts is required at the line input to operate the most remote line relay, and the normal line current is 100 ma. To provide the 100 volts and still limit the current due to a nearby shunt at the control office to 500 ma., in order to protect relay contacts, a 125-volt battery with a 250-ohm series resistance will be required.

With the line voltage and current specified, the unshunted line resistance is of course 1000 ohms. When the most remote location shunts the line this input resistance is reduced to perhaps 900 ohms. The shunted line current will be 109 ma. and the differential current 9 ma. This is below the minimum value of current (15 ma.) that will operate the office line relay through the impulse transformer.

It might appear that the solution is to boost the line battery voltage enough to obtain the proper differential current, but this may be erroneous. The larger the battery the poorer the regulation because of the larger series limiting resistance required. Moreover, it is impractical to use more than 250 volts line battery because of relay contact difficulties, such as inability to extinguish arcs, etc. However, in an effort to obtain a workable differential current with a 250-volt battery, it will be necessary to insert 500 ohms series resistance to prevent the office shunt current from exceeding 500 ma. Under these conditions the differential current will be about 11 ma., still less than the required value.

With the line power supply unit, suitably adjusted for the same conditions, a shunt at the most remote location will cause the line voltage to rise from 100 volts to 117, and the line current to rise from 100 ma. to 128 ma. This results in a differential current of 28 ma., adequate to operate the office line relay. Also, the line current drawn by a shunt at the control office, instead of being 500 ma., will be only 160 ma.

The new line power supply permits the use of less expensive line wire, of smaller size or lower conductivity, for any given distance. Also, longer distances are operable with the same size wire. Because it replaces the line battery, space requirements are less. However, the unit requires an inverter or other means of obtaining 115 volts, 60-cycle a.c. from the local battery in case of commercial power failure. Power consumption of the unit is approximately 100 watts, and this must be considered in determining the size of the local battery.

NEW ROTARY SWITCH FOR G-R-S CONTROL MACHINES

Relay interlocking control machine operating panels can now be furnished with all control levers on the track diagram due to the development of a rotary switch lever with a built-in point indicator.

The new lever knob and point indicator for a single crossover is shown in Figure 4A, for a double crossover in Figure 4B, and for a turnout in Figure 4C.

The indicator is positioned by knob movement through the medium of a coil spring wound on a sleeve which slips over the barrel inside the knob.

The entire assembly of the switch is shown in Figure 5.

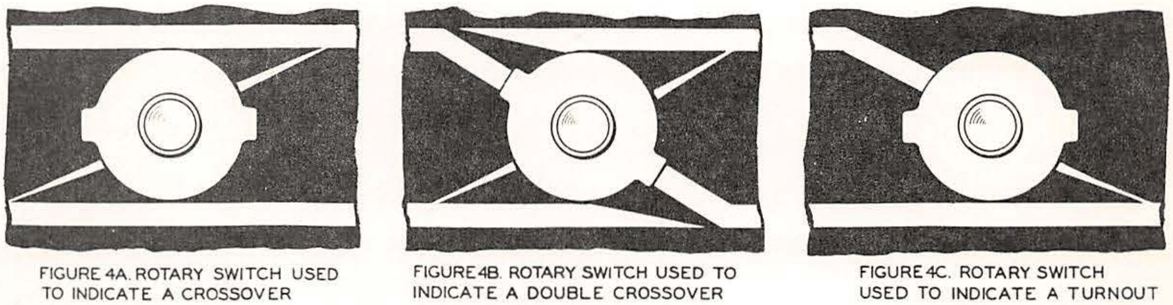


FIGURE 4A. ROTARY SWITCH USED TO INDICATE A CROSSOVER

FIGURE 4B. ROTARY SWITCH USED TO INDICATE A DOUBLE CROSSOVER

FIGURE 4C. ROTARY SWITCH USED TO INDICATE A TURNOUT

Figure 4. Rotary switch applications.

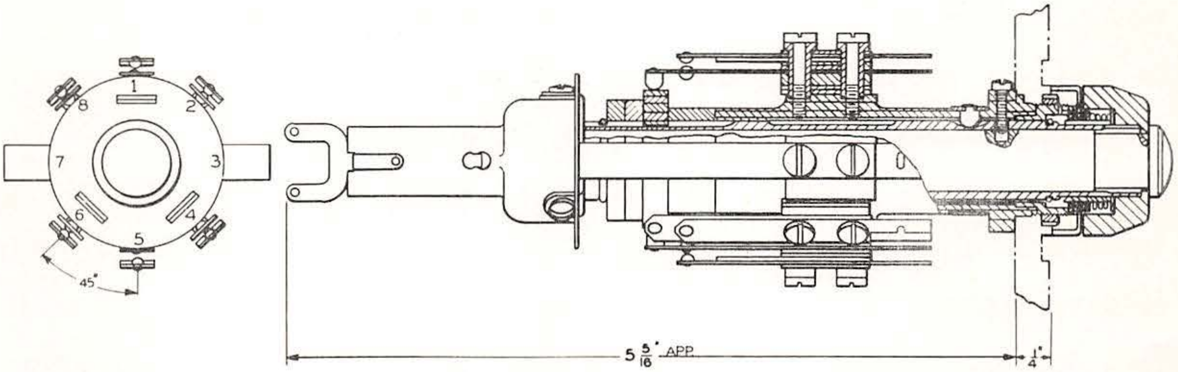


Figure 5. Rotary switch with built-in switch indicator.

G-R-S CLAMP BASES FOR SIX-INCH PIPE

Clamp type bases are now available for mounting 6-inch signal masts (6-5/8-inch O.D. pipe). Figure 6 shows the plain clamp base,

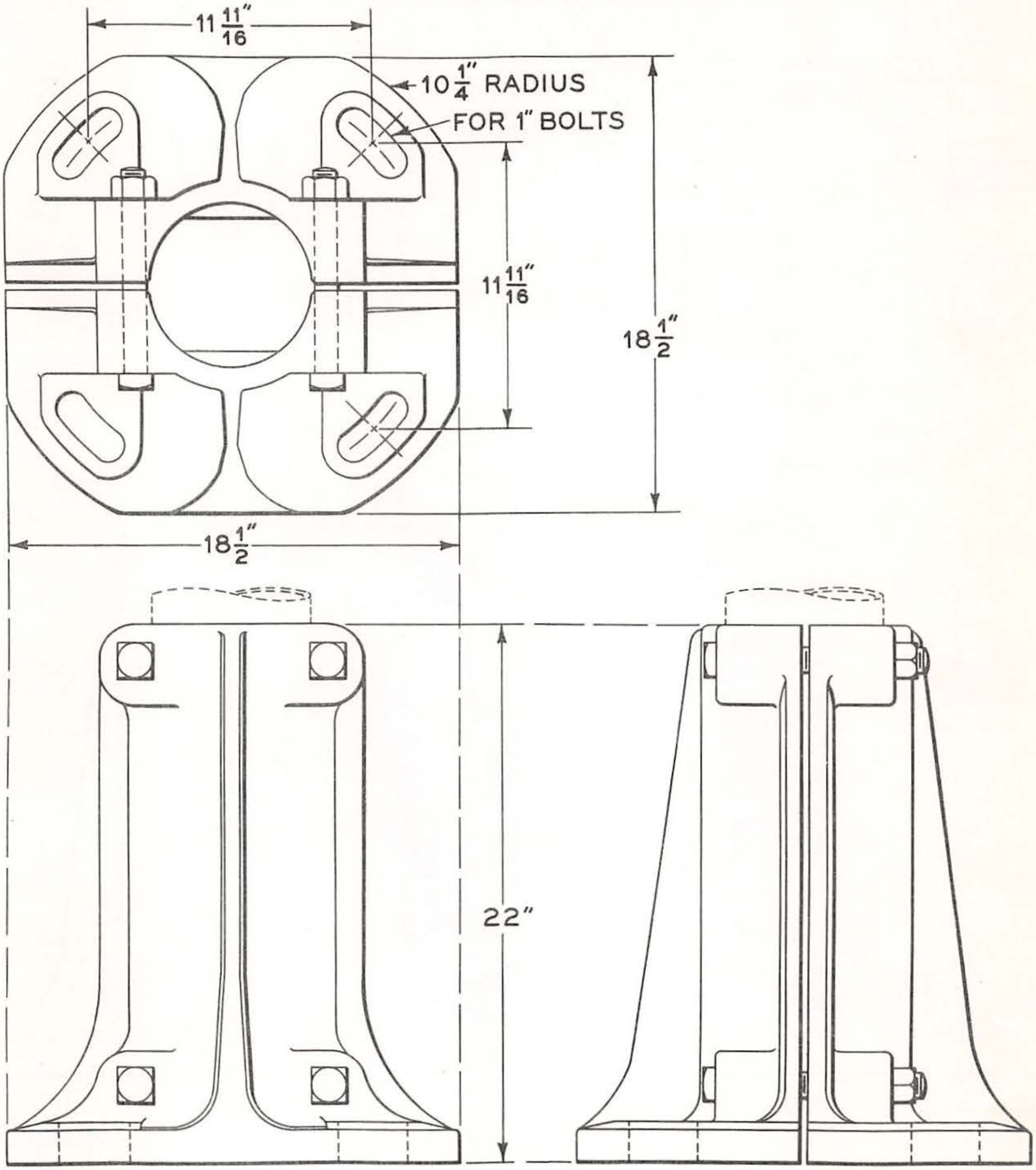

11 11/16"
10 1/4" RADIUS
FOR 1" BOLTS
11 11/16"
18 1/2"
18 1/2"
22"

Figure 6. Clamp base for mounting 6-inch signal mast.

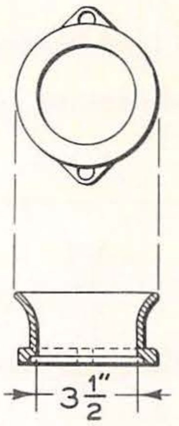
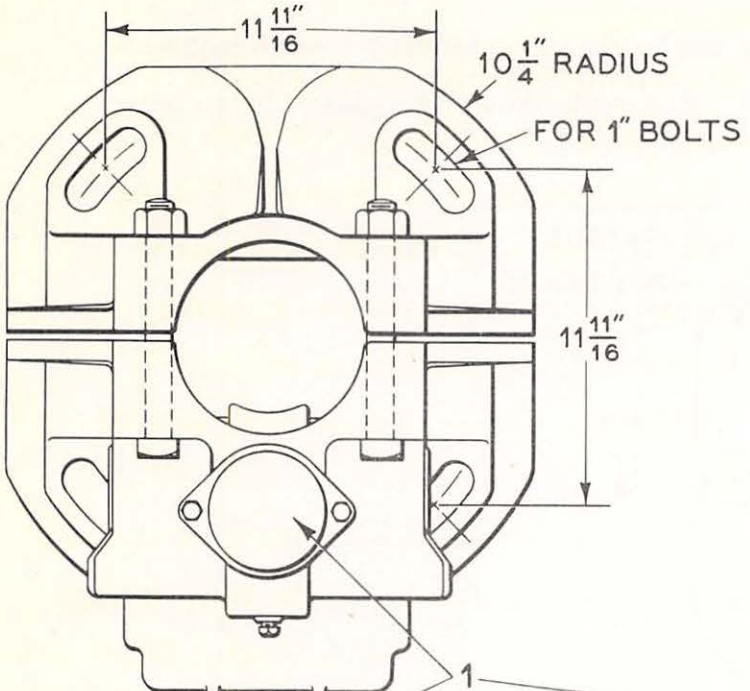


Figure 7a. Coupling for junction box base.


11 11/16"
10 1/4" RADIUS
FOR 1" BOLTS
11 11/16"
1

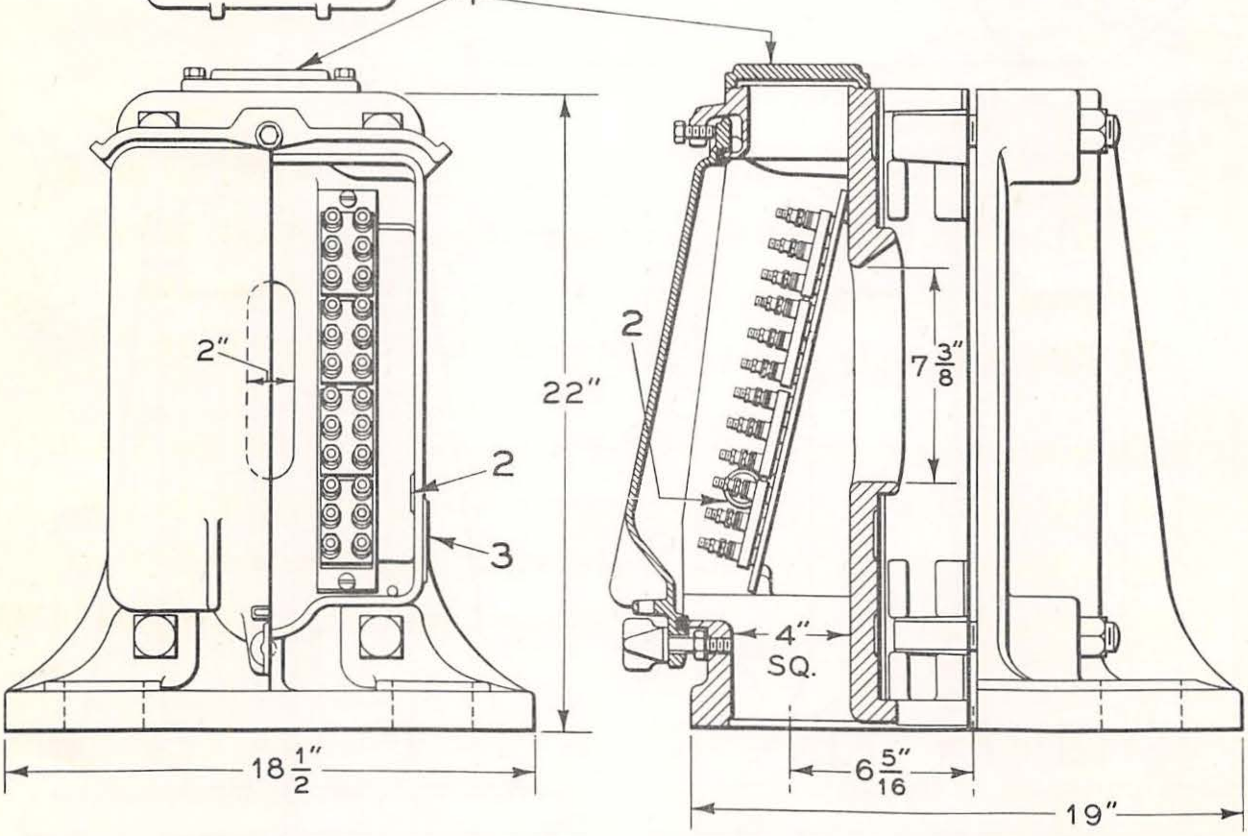

2"
22"
2
3
18 1/2"
2
7 3/8"
4" SQ.
6 5/16"
19"

Figure 7. Clamp base with junction box.

and Figure 7 shows base with junction box.

The junction box base has two terminal blocks with a total of 48 A.A.R. No. 14-24 binding posts and 24 connectors. A 4-inch square cable entrance is provided in the bottom of the base. Wiring may be brought up inside the mast through a 2-inch by 7-3/8-inch opening; or an outlet fitting, Figure 7a, may be installed in place of cap 1. Bosses on either side, as at 2, may be drilled and tapped for 1/2-inch pipe ventilators. Bosses on either side, as at 3, may be drilled and tapped for 2-inch pipe.

In tests to destruction, these new clamp type bases withstood loadings in excess of the maximum load limit for solid bases of the same design. They also withstood loadings in excess of the safe loading limit for 6-inch extra strong pipe.

Item	Order Number
Base complete (Figure 6).	43951-22 Gr. 1
Base complete with junction box(Figure 7).	43951-21 Gr. 1
Coupling for junction box (Figure 7a).	45689-162
Drilling diagram for pole for junction box base . . .	49185-571

These bases were developed by G-R-S in cooperation with the A.A.R. Signal Section. A.A.R. drawings of these bases will appear in the 1953 Advance Notice. A.A.R. drawing numbers for plain base are 1475A and 1476A; for junction box base, A.A.R. numbers are 1477A, 1478A, and 1479A.

PATENTS

The Company wishes to congratulate its employees who have had patents issued to them. Copies of these patents will be furnished by the Patent Department upon request made by the inventors involved and those others who may profitably use printed copies of the patents in connection with the Company's work.

Inventor's Name	Pat. No.	Date	Invention
J. J. Jacobus	2,581,108	1-1-52	A system of signal control governed by a dragging equipment detector.
B. M. Stright	2,581,820	1-8-52	A liquid or paste non-corrosive soldering flux for electrical connections.
R. F. Wells	2,582,089	1-8-52	A circuit to check the proper response of the polar contacts on a polar neutral relay.
E. C. Larry	2,584,719	2-5-52	A front rod for switch machines.
F. X. Rees & R. Bechtold	2,584,739	2-5-52	Syncropulse system (a cTc code system employing electron tubes instead of relays).
J. Y. Howard	2,588,005	3-4-52	A coded track circuit system having approach track relays compensated for voltage changes in the track battery.
J. C. O'Brien & H. C. Sibley	2,588,031	3-4-52	A squelch circuit for a radio receiver.
W. H. Reichard	2,588,044	3-4-52	A coded track circuit system.
O. S. Field & J. E. Freehafer	2,588,916	3-11-52	Air navigation system.
H. C. Kendall & L. H. Orpin	2,588,930	3-11-52	Airways block signaling system.
H. C. Kendall & L. H. Orpin	2,588,931	3-11-52	Improved airways block signaling system.
E. H. Branson	2,592,788	4-15-52	A combined wire marker and terminal protector.

G-R-S NEWS
February 1953

In this issue:

Model 9B electric switch lock.

MODEL 9B ELECTRIC SWITCH LOCK

Purpose

The purpose of the Model 9B electric switch lock is to lock the lock rod on a switch as shown in Figure 2. It may be used to lock the lock rod in one position only; or, if equipped with a double adjustable lock rod, it may be used to lock the lock rod in either the normal or the reverse position. The Model 9B lock may also be used to lock any device which can be locked with a lock rod.

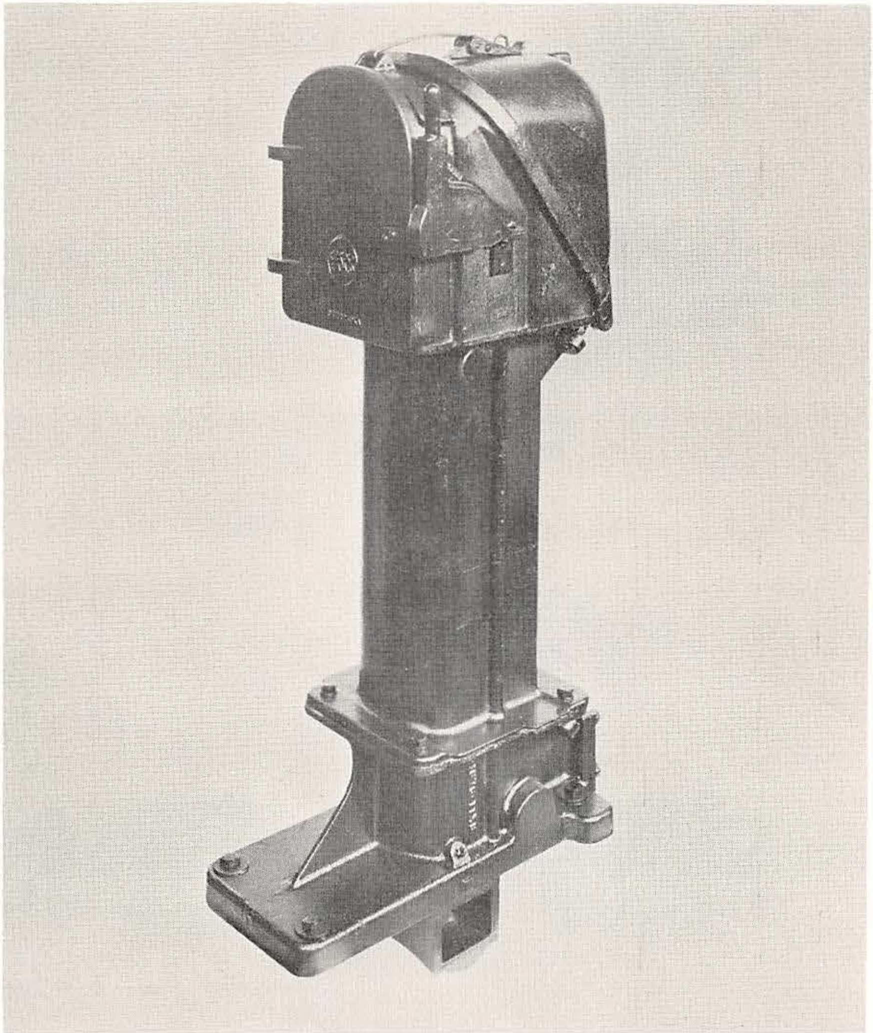


Figure 1. The Model 9B lock.

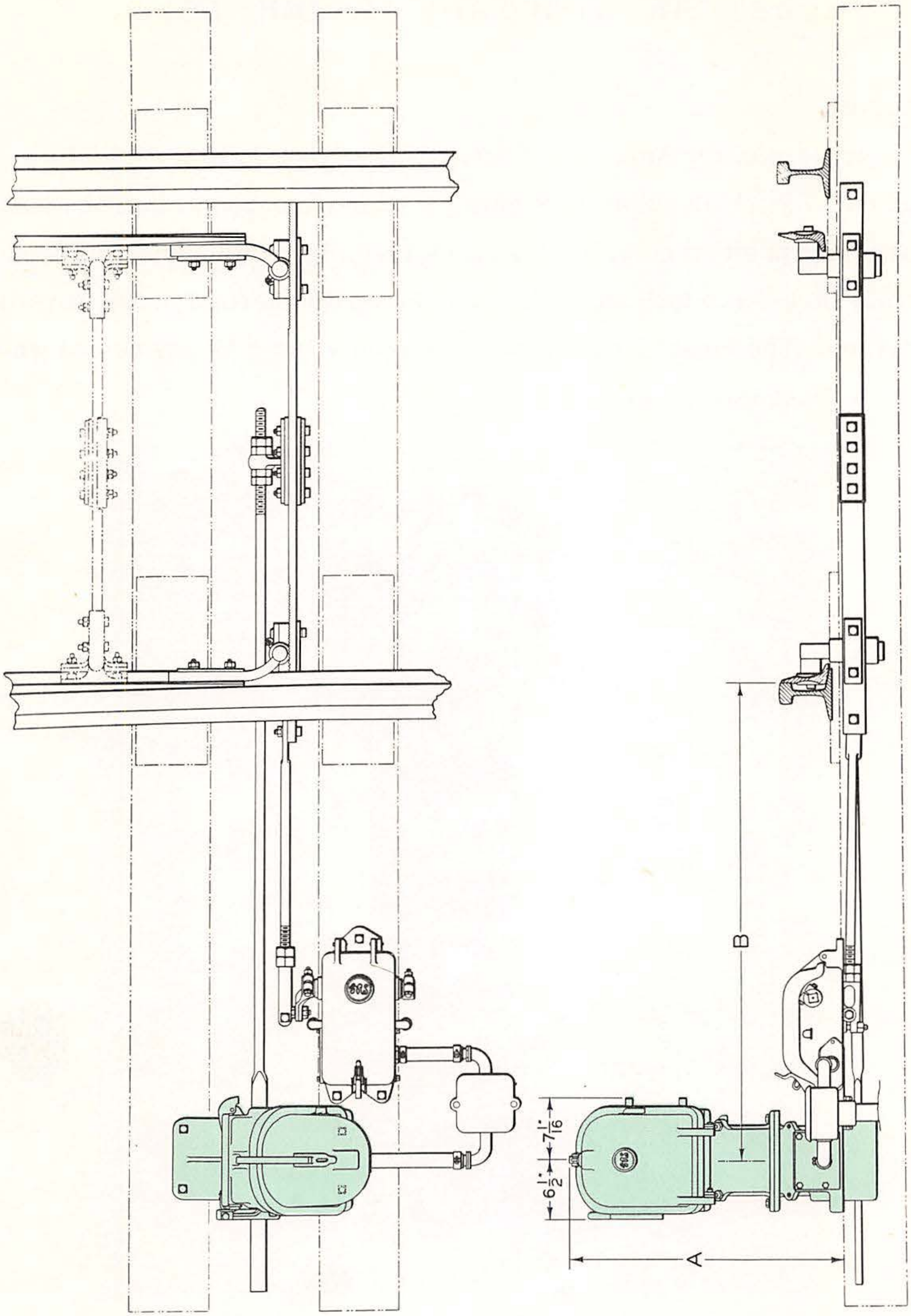


Figure 2. Model 9B lock installed on two ties.

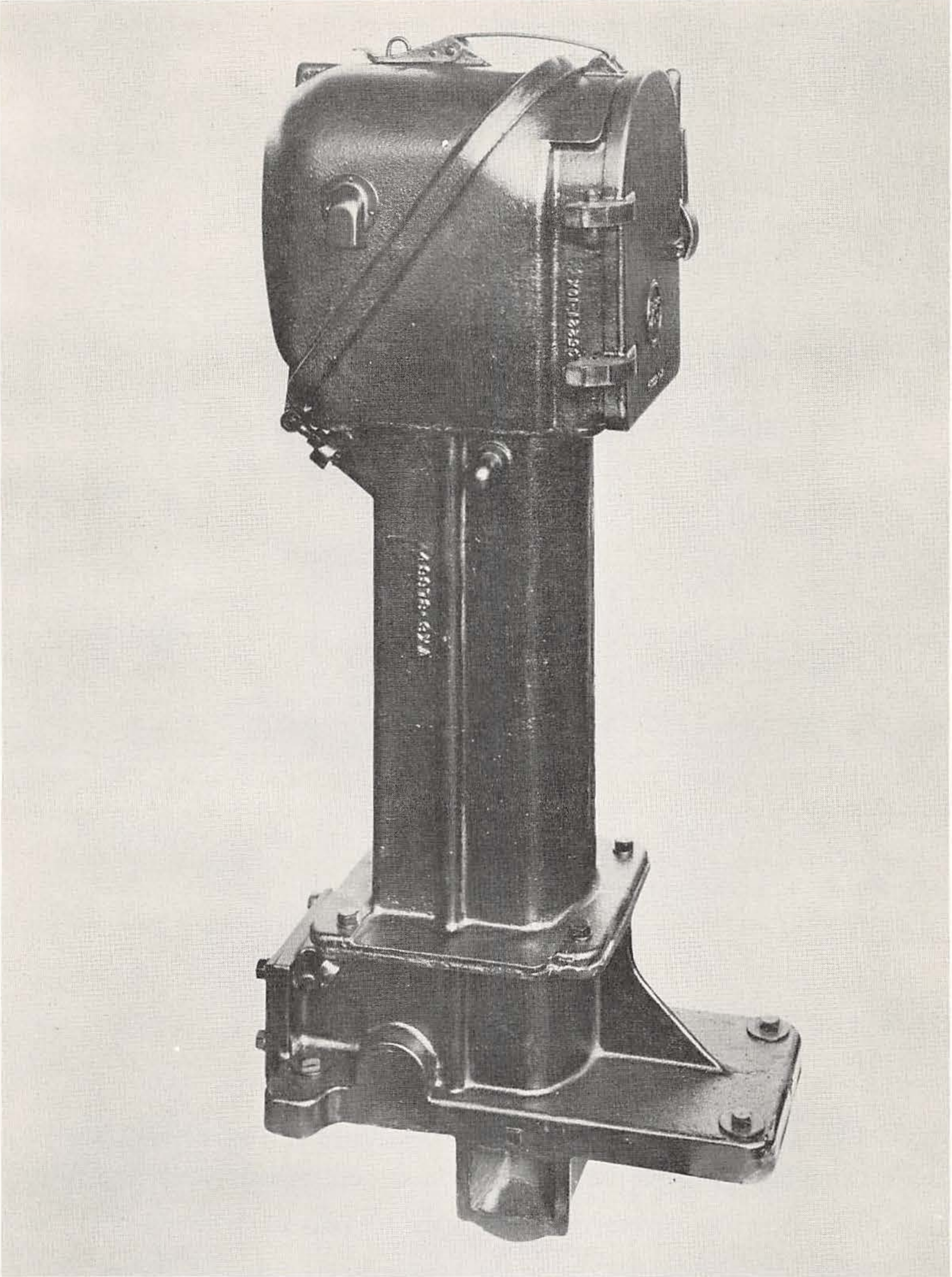


Figure 3. Left side view of high lock.

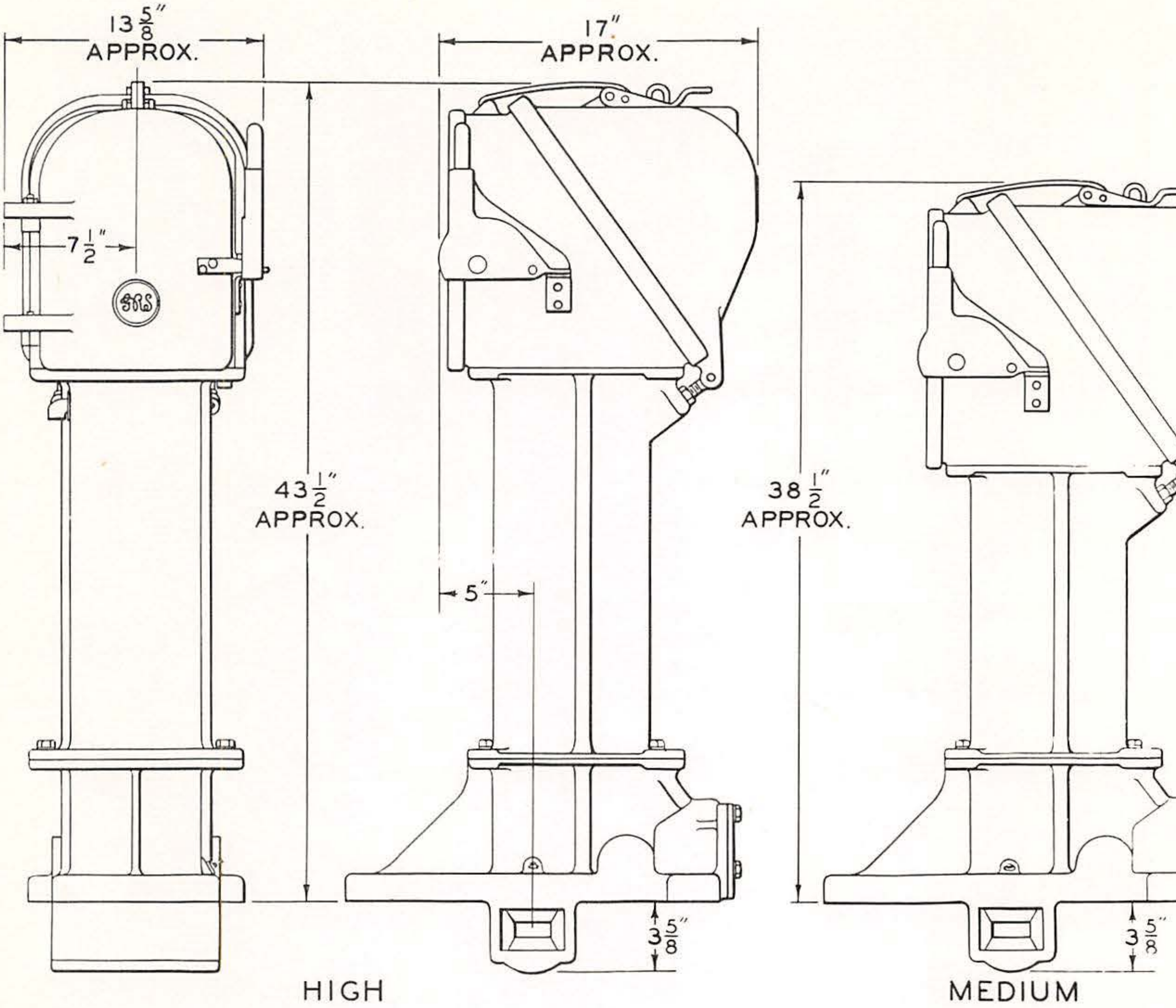
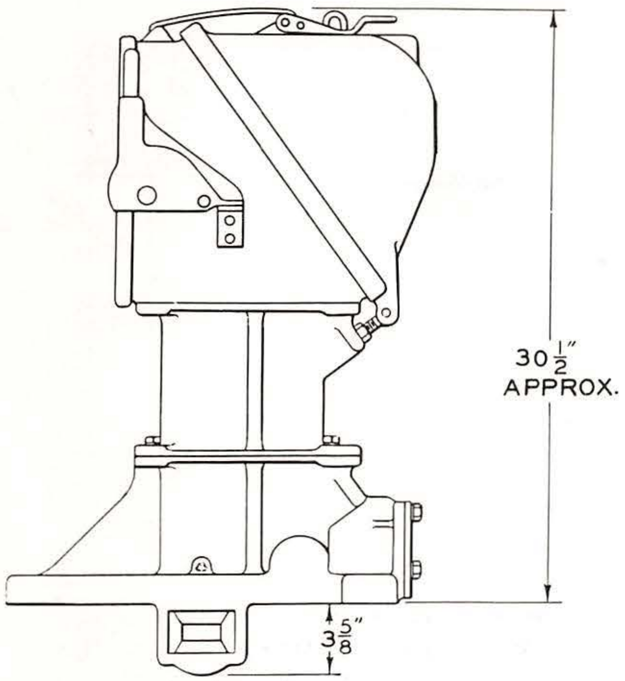

13 5/8" APPROX.
17" APPROX.
7 1/2"
GRS
43 1/2" APPROX.
38 1/2" APPROX.
5"
3 5/8"
3 5/8"
HIGH
MEDIUM

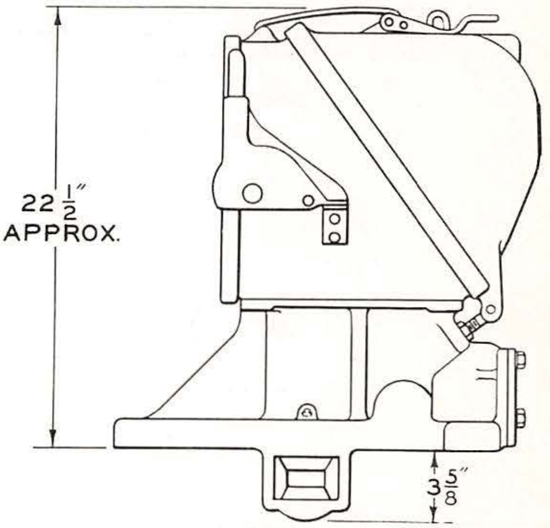
Figure 4. Four heights are available.

OPERATION

The Model 9B, Figure 4, is an electrically operated lock in which the locking key is lifted from a notch in a locking dog by an electromagnet, thus permitting the trainman to raise the locking plunger out of its hole in the switch lock rod by operating the handle to its full 180 degree reverse position. This operation and these parts are explained in detail later.


$30\frac{1}{2}''$
APPROX.
$3\frac{5}{8}''$

LOW


$22\frac{1}{2}''$
APPROX.
$3\frac{5}{8}''$

DWARF

HEIGHTS

The lock is manufactured in four heights, as shown in Figure 4, measured from the top of the tie to the top of the lock, as follows-

High	43-1/2''
Medium	38-1/2''
Low	30-1/2''
Dwarf	22-1/2''

All mechanism cases and lock bases are made in standard heights. Heights of the lock are varied by using pedestals of different heights between the bases and the mechanism cases. In the dwarf lock the mechanism case is bolted directly to the base.

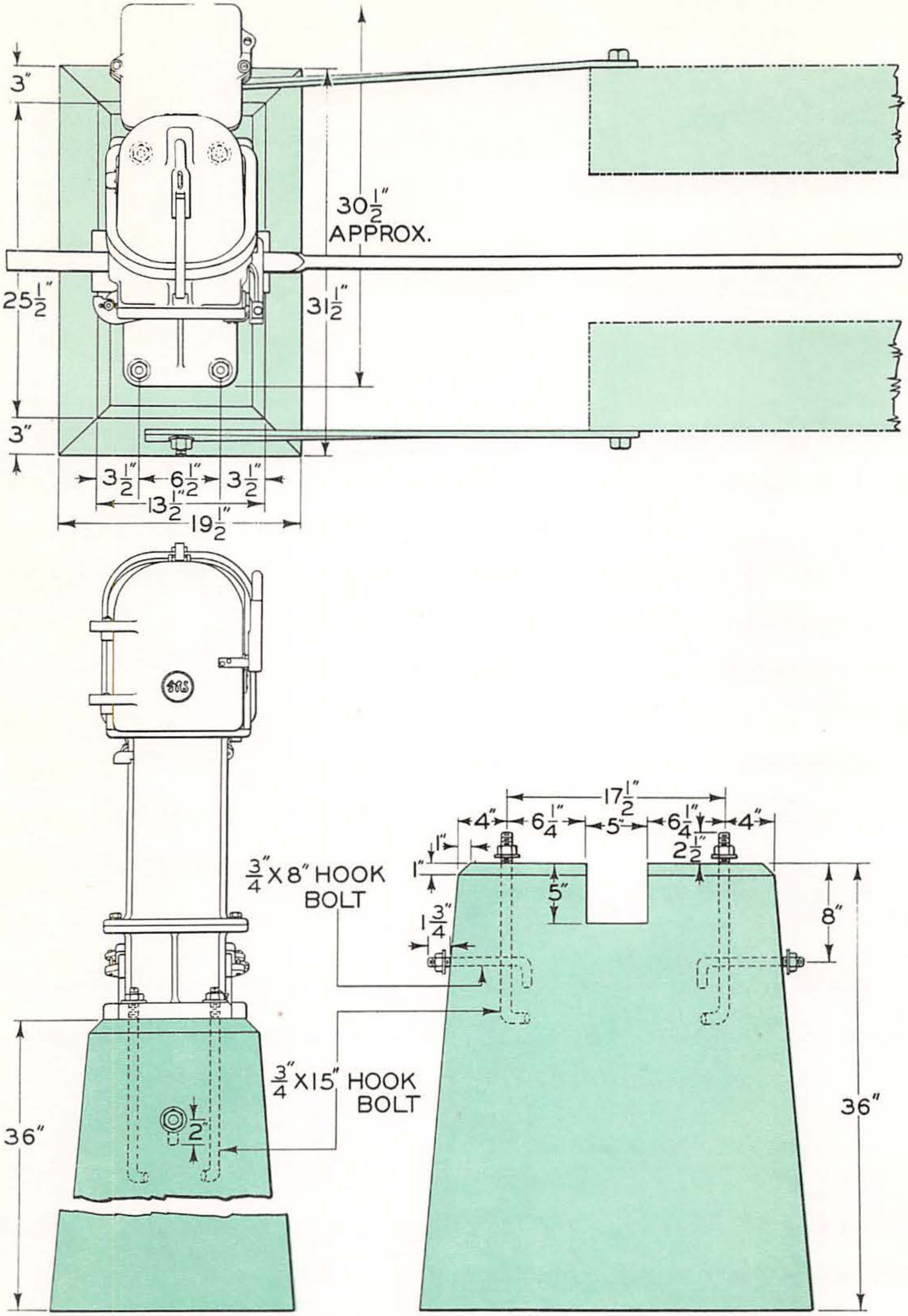

3"
25 1/2"
3"
30 1/2" APPROX.
31 1/2"
3 1/2"
6 1/2"
3 1/2"
13 1/2"
19 1/2"
3/4" X 8" HOOK BOLT
3/4" X 15" HOOK BOLT
36"
2"
17 1/2"
4"
6 1/4"
5"
6 1/4"
4"
1"
1"
2 1/2"
5"
1 3/4"
8"
36"

Figure 5. A concrete foundation is recommended for medium and high locks.

LAYOUT AND INSTALLATION

Figure 2 shows a typical layout and installation plan where the lock is mounted on the ties. The lock may be placed on either side of a switch layout. The lock is centered on the ties so that there is unrestricted movement of the lock rod. The lock may be bolted to the ties. Dimension A may be any of the heights shown in Figure 4, and depends on clearance available. Dimension B will depend on the railroad's standards.

Figure 5 shows the Model 9B lock mounted on the type of concrete foundation recommended for the medium and high locks. There is ample clearance in the 5-inch square slot for the base lug. Note the steel tie straps between the concrete foundation and the ties to hold the distance from lock to rail constant. The attached junction box is recommended only where the lock is mounted on a concrete pedestal.

A separate junction box, as shown in Figure 2, should be used where the lock is subject to excessive vibration, as on the end of long ties. Solid wires of the underground cable are terminated in the junction box, and flexible wires are run from the junction box into the lock.

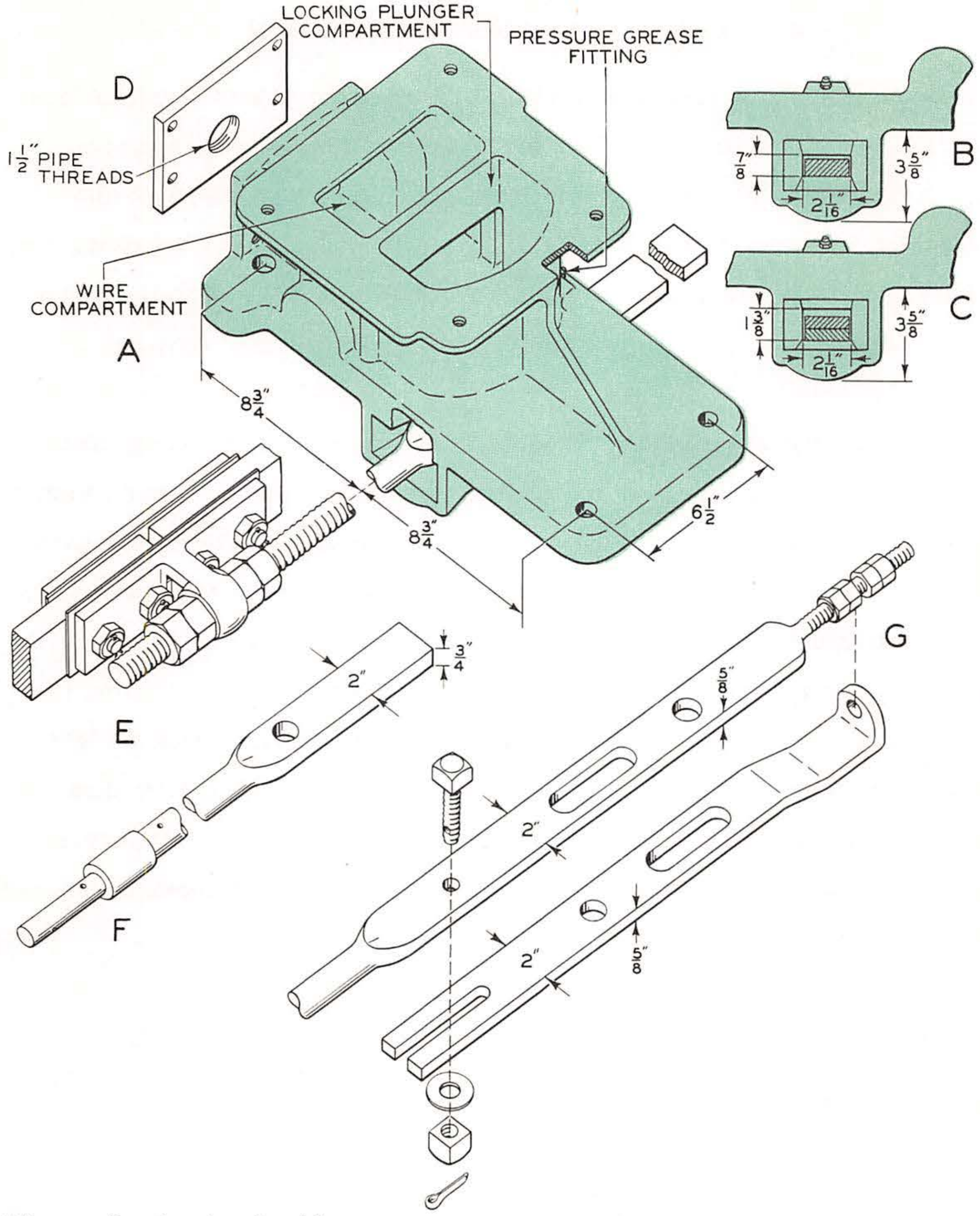

LOCKING PLUNGER COMPARTMENT
PRESSURE GREASE FITTING
D
1½" PIPE THREADS
WIRE COMPARTMENT
A
8¾"
8¾"
6½"
B
7/8"
3⅝"
2 1/16"
C
1⅜"
3⅝"
2 1/16"
E
3/4"
2"
F
G
5/8"
2"
2"
5/8"

Figure 6. A-standard base.
B-base detail for single lock rod.
C-base detail for double adjustable lock rod.
D-wire entrance plate.
E-threaded end lock rod.
F-tang end lock rod.
G-double adjustable lock rod.

BASES

The standard base furnished with the Model 9B lock is the open type, Figure 6A. This base is designed to be bolted to the pedestal, or directly to the mechanism case when the lock is used as a dwarf. It has two compartments, as does the pedestal, one for wires and the other for locking plunger. Either a wire entrance plate, D, or the junction box (see Figure 5) may be bolted to the wire compartment. A pressure grease fitting is provided for lubricating the locking plunger. Mounting holes are identical with the Model 9A lock so the Model 9B lock can be used on the same foundation. This base can be furnished for either the single or the double adjustable lock rod as shown in B and C. The open type base is the only base which will accommodate the double adjustable lock rod, shown at G.

The double adjustable lock rod is made adjustable by combining two rods with slots and round holes as shown. These are provided so that the locking plunger holes may be adjusted for locking the lock rod in both the normal and the reverse positions to fit throw of switch. Two types of lock rod ends are shown in E and F, threaded and tang. The tang-end lock rod is pipe-connected to the switch.

Single lock rods will be furnished drilled for closed point only unless otherwise specified.

A watertight base is offered as an optional feature on the Model 9B lock, as shown in Figure 7A. Instead of the open lock rod slot in Figure 6, there is a stuffing gland, B, which encloses the lock rod. Lock rods are available with threaded ends or tang ends. This arrangement provides locking in one position only. An enlarged cross-section of the stuffing gland is shown at C. Two leather washers surround the packing. Tightening the gland forces the packing snugly around the lock rod shaft, making the base watertight.

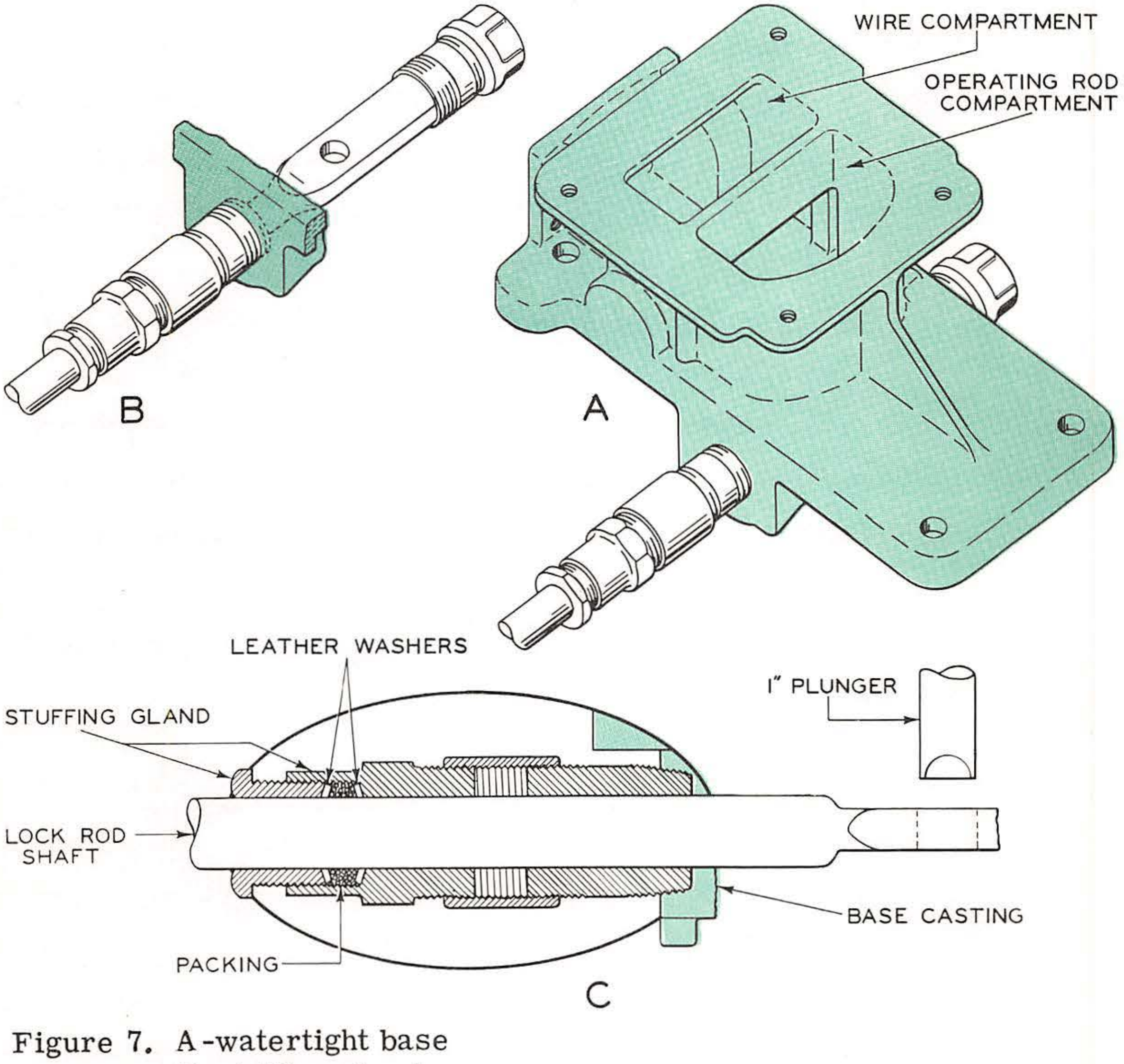

WIRE COMPARTMENT
OPERATING ROD COMPARTMENT
B
A
LEATHER WASHERS
STUFFING GLAND
I" PLUNGER
LOCK ROD SHAFT
BASE CASTING
PACKING
C

Figure 7. A-watertight base
B-stuffing gland
C-cross-section of stuffing gland

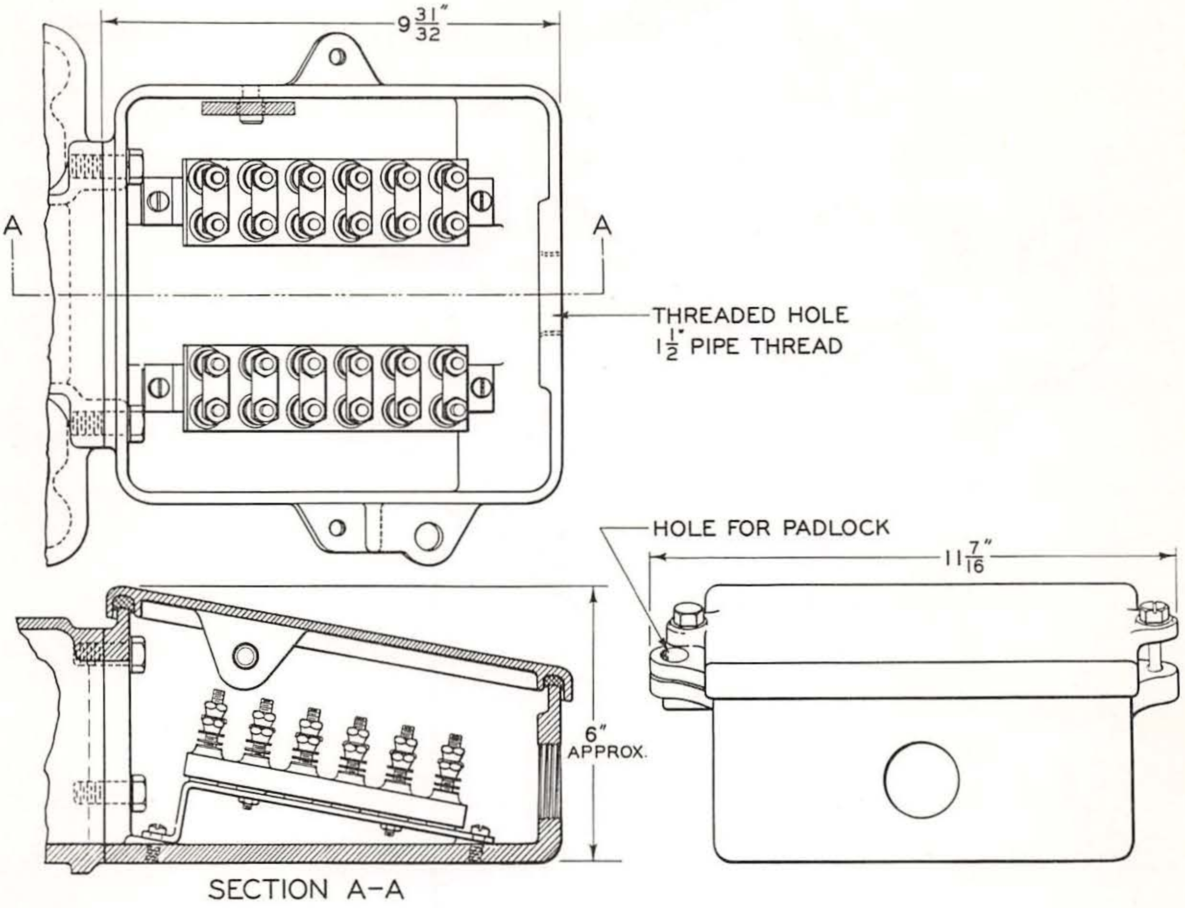

9 31/32"
A
A
THREADED HOLE
1½" PIPE THREAD
HOLE FOR PADLOCK
11 7/16"
6" APPROX.
SECTION A-A

Figure 8. The junction box, an optional feature, is used when the lock is mounted on a concrete base.

JUNCTION BOX

The junction box, Figure 8, is an optional feature used when the lock is mounted on a concrete base. The junction box is fastened to the base at the rear of the lock with four cap screws in place of the wire entrance plate, Figure 6D, usually supplied. A sealing compound is used to seal the two adjoining surfaces. Cable may be brought directly into the junction box through a fitting which may be applied to the 1-1/2-inch wire-entrance hole which has pipe threads. Inside the junction box are two terminal

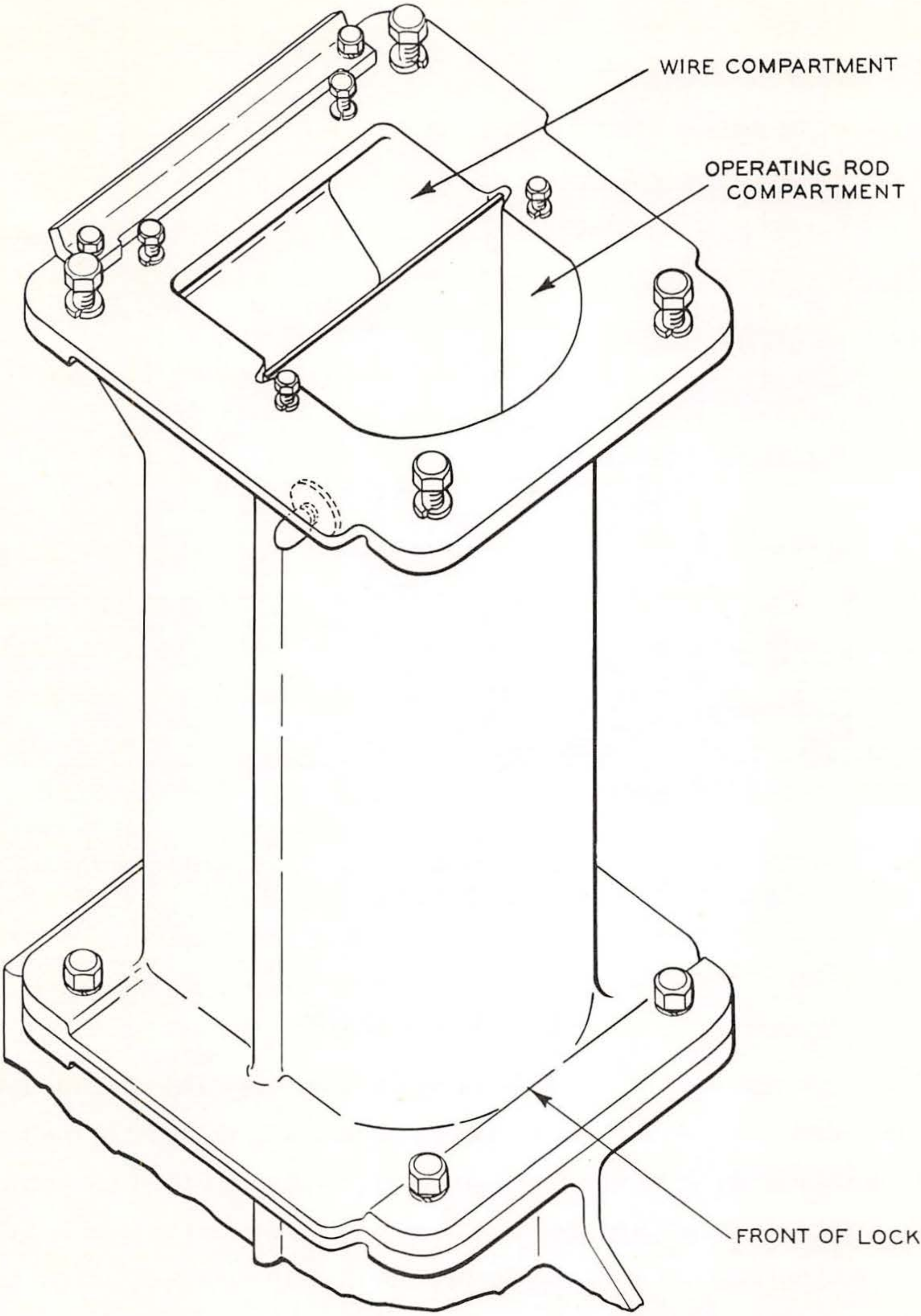

WIRE COMPARTMENT
OPERATING ROD COMPARTMENT
FRONT OF LOCK

Figure 9. A cast iron pedestal supports the lock, has separate compartments for wiring and operating rod.

blocks, one on either side of the center, with twelve terminals to a block. The cover of the junction box is fastened down with two cap screws which are necked to prevent losing them when the cover is removed. Matching padlock holes are provided on one side of the case and the cover. To prevent the cover from being pried off at the opposite side, a lug is cast on the cover which fits over a pin projecting from the side of the case. The cover is gasketed to provide a weathertight seal.

Ready access is afforded for wiring between the junction box and the mechanism case through the base and the pedestal.

PEDESTAL

The cast iron pedestal, Figure 9, is made in three heights as shown in Figure 4. The pedestal is divided in its central portion by a sheet metal partition which rests on a cast iron bridge in the base. The front compartment provides room for the operating rod, weight and locking plunger. The back compartment provides room for wires from the base to the mechanism. A ventilator is provided in the pedestal near the top. The four smaller cap screws at the top of the pedestal are for bolting down the mechanism. The four larger cap screws are for bolting down the case, which is open at the back. A separate filler bar, bolted to the rear of the pedestal, closes the gap in the case. Thus the case may be removed and the mechanism left exposed for easy maintenance without disconnecting wires. A sealing compound is used between the pedestal and the base and between the pedestal and the case.

CASE

The case, Figure 10, is made of cast iron with an integral partition separating the mechanism from the operating handle compartment. As noted previously, the case is open at the back for easy removal from the pedestal. The indicator glass and bezel are fastened to the cast partition,

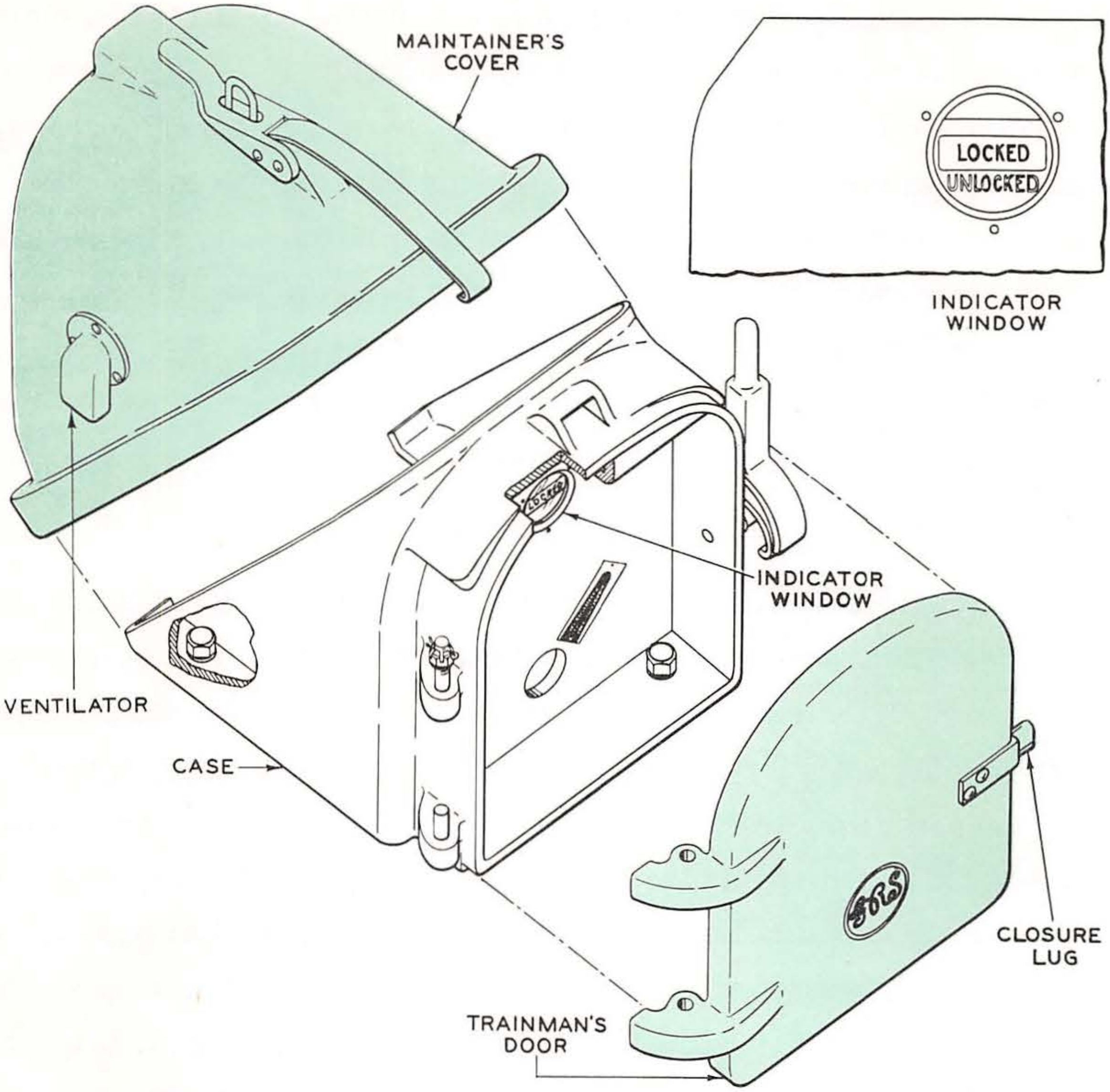

MAINTAINER'S COVER
LOCKED
UNLOCKED
INDICATOR WINDOW
INDICATOR WINDOW
VENTILATOR
CASE
CLOSURE LUG
TRAINMAN'S DOOR

Figure 10. The cast iron case carries the maintainer's cover and the trainman's door.

just below the top of the case. Hinge lugs are cast on the left-hand side of the case for the trainman's door. The trainman's handle is on the right-hand side. A lug is cast on top of the case for the latch strap on the maintainer's cover. The case may be removed from the pedestal by removing the operating handle and taking out four cap screws.

The operating handle is removed by driving out a roll pin fastening the hub to the shaft and pulling the handle off the shaft. If the lock is equipped with optional features such as a pushbutton, emergency release or door circuit controller, the wires to these accessories must be disconnected before removing the case or they must be long enough to provide slack when the case is removed.

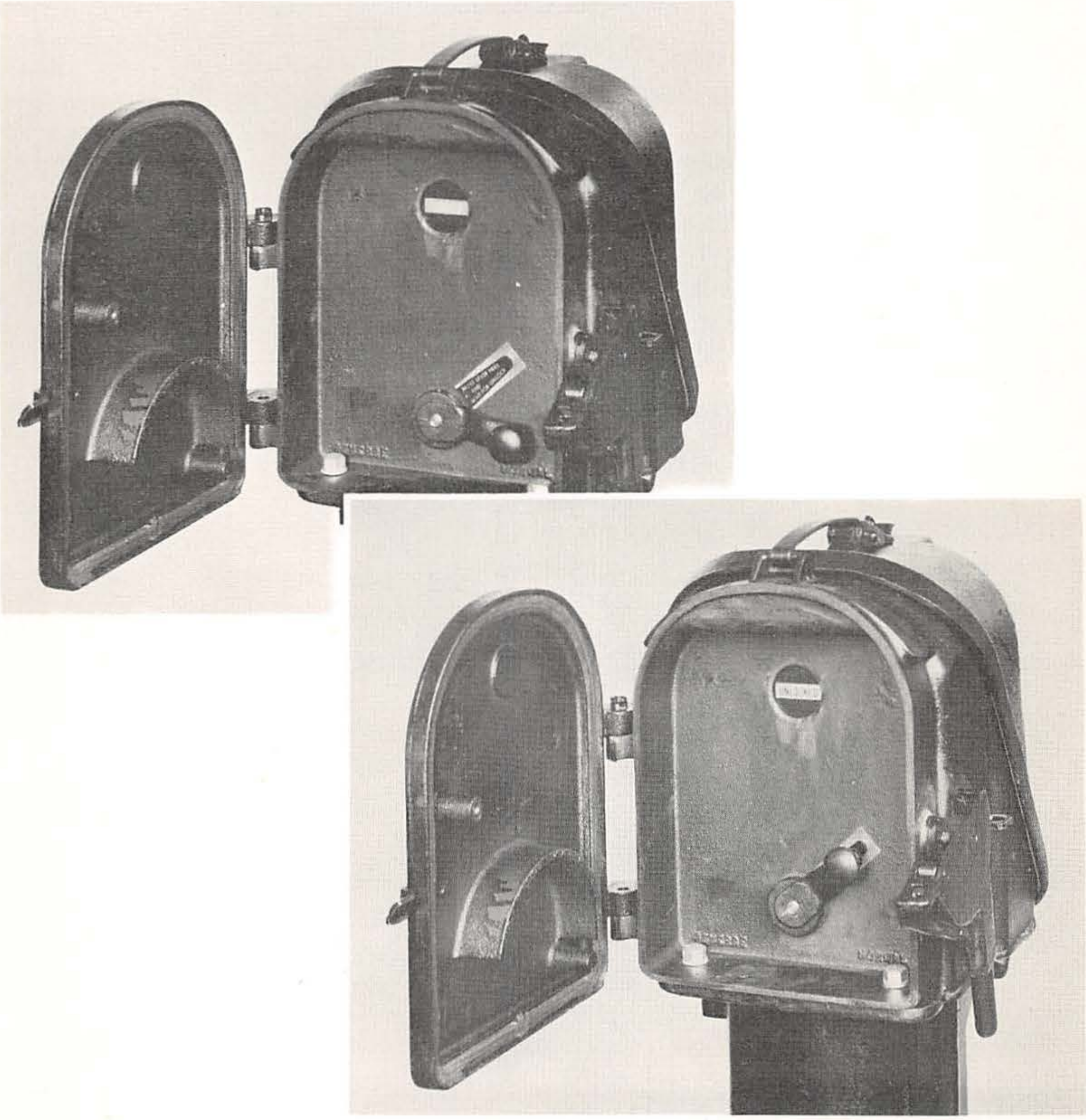


Figure 11. The 9B lock as the trainman sees it showing operating handle in the normal and in the 45 degree position.

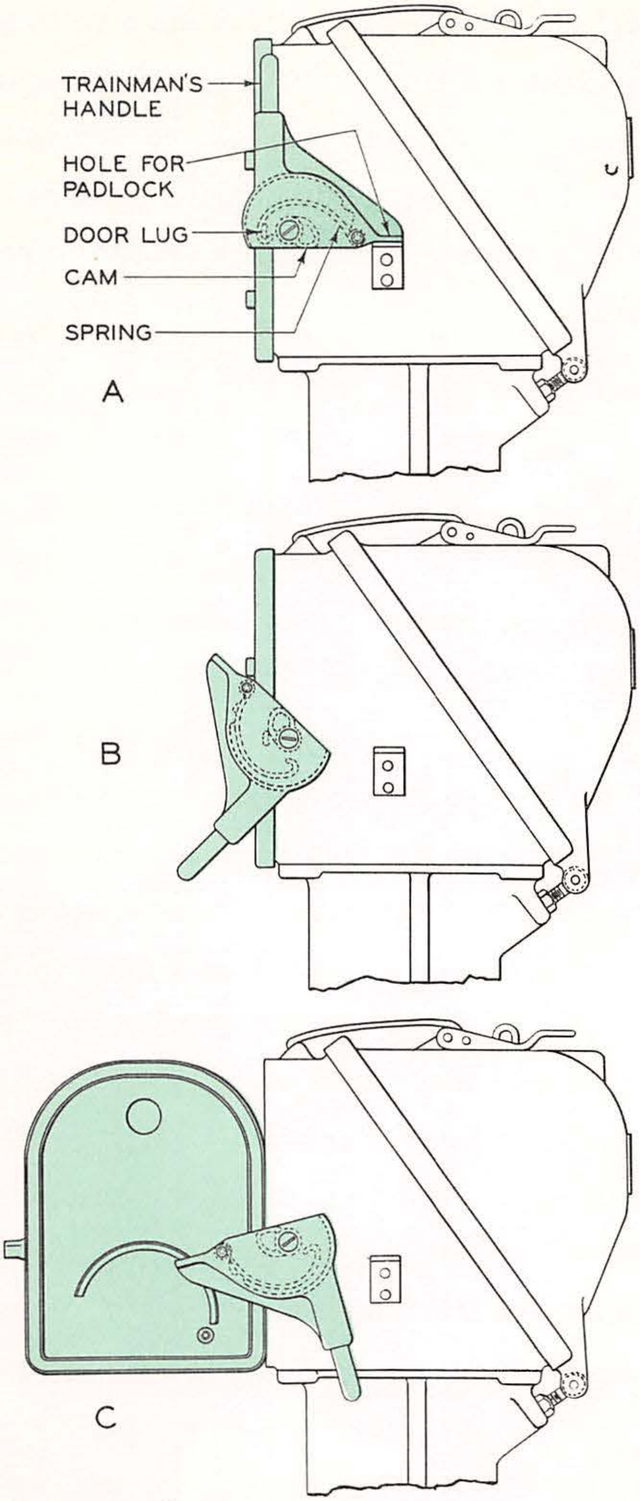

TRAINMAN'S HANDLE
HOLE FOR PADLOCK
DOOR LUG
CAM
SPRING
A
B
C

Figure 12. Trainman's door.
A - closed
B - cam in handle bearing against door lug
C - fully opened.

TRAINMAN'S DOOR

The trainman's door, shown in Figures 10 and 12, fastens to the hinge lugs cast on the left-hand side of the case. The lugs on the trainman's door do not allow it to open beyond the right angle or 90 degree position. The hinge pins are plated to prevent corrosion. The top hinge pin is threaded as shown in Figure 10. A castellated nut is screwed down on top of the hinge lug and fastened with a cotter pin. This prevents the door being lifted off the hinges.

A full lug is cast on the inside of the trainman's door, as shown in Figure 12C. This lug prevents the door from being closed until the operating handle is in the normal or 0 degree position. Only then can the door be latched and the padlock applied.

Figures 10 and 12 show the closure lug on the right-hand side of the door. This lug fits into the trainman's handle, a combination latch-locking device. In Figure 12A the door is shown closed and latched ready to be padlocked. The spring inside the trainman's handle is engaging the lug on the trainman's door and holding it compressed against the front of the case. When the trainman's handle is pulled forward and down, Figure 12B, the spring releases the door lug, and a cam which is cast into the handle bears against the lug, thus forcing the door open. This feature assures easy opening of a door which goes unused for long periods or in times of ice formation, sleet storms, etc. Figure 12C shows the lock with the door open in the 90 degree position and the handle in its fully unlatched position. Starting with the door open, as at C, the procedure in closing and latching the door is to bring the door to its almost closed position. At that point the door lug is in the space between the spring and the cam on the handle. Bring the handle up beyond the position shown at B. At that position the hook on the end of the spring catches the lug on the door and forces it tightly closed by the snap action of the spring and the handle as shown at A. The handle may then be padlocked.

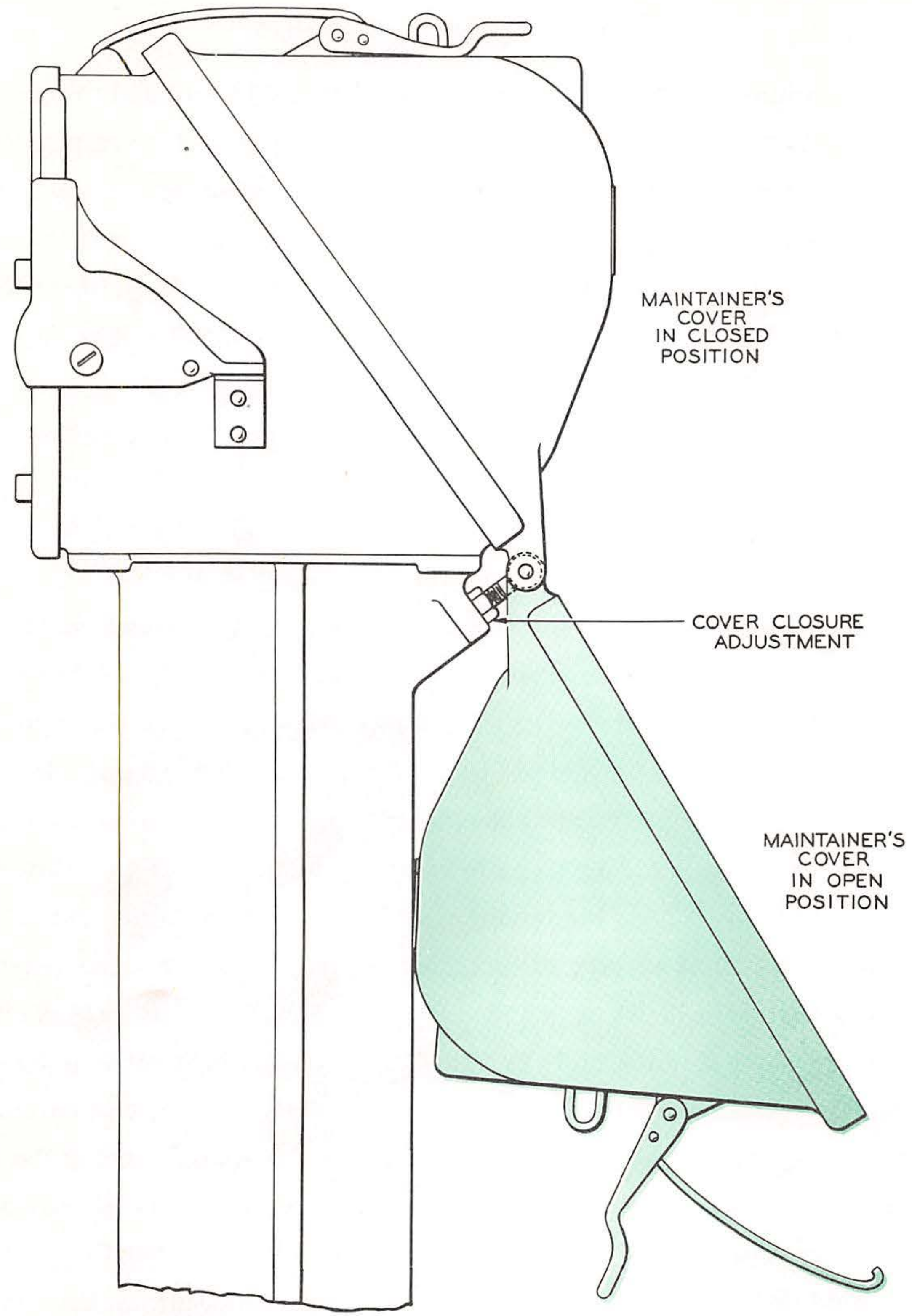

MAINTAINER'S COVER IN CLOSED POSITION
COVER CLOSURE ADJUSTMENT
MAINTAINER'S COVER IN OPEN POSITION

Figure 13. The maintainer's cover swings down out of the way providing easy access to the mechanism.

MAINTAINER'S COVER

The maintainer's cover, Figure 13, has two lugs at the bottom through which it is hinged to the pedestal. A cover closure adjustment is provided on the eyebolts which act as hinges. These hinge pins are plated to prevent corrosion. The cover is provided with a latch for padlocking at the top. When the cover is open the mechanism is well exposed for inspection. A ventilator is provided on the cover as shown in Figure 10.

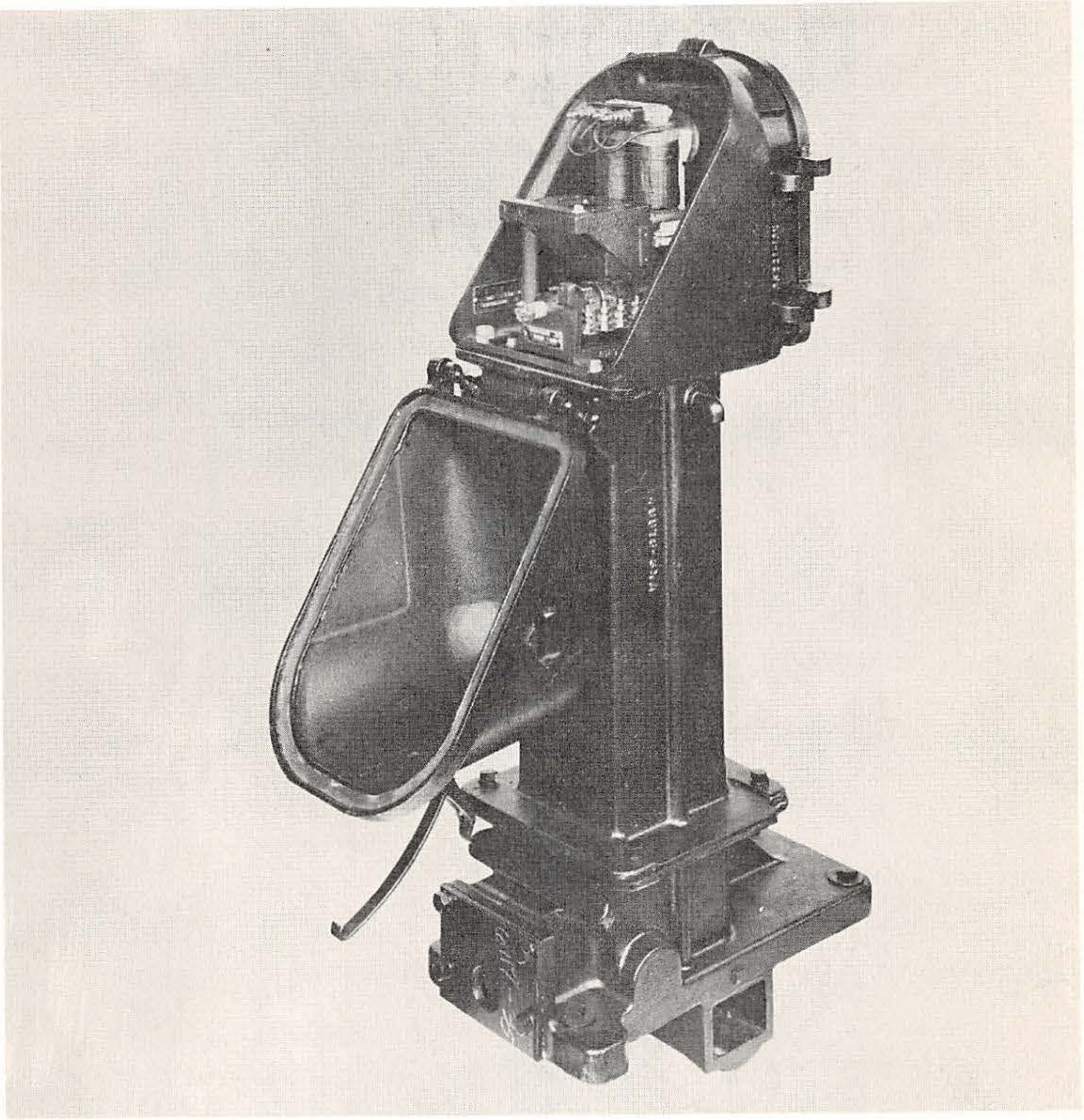


Figure 14. Maintainer's cover open showing mechanism.

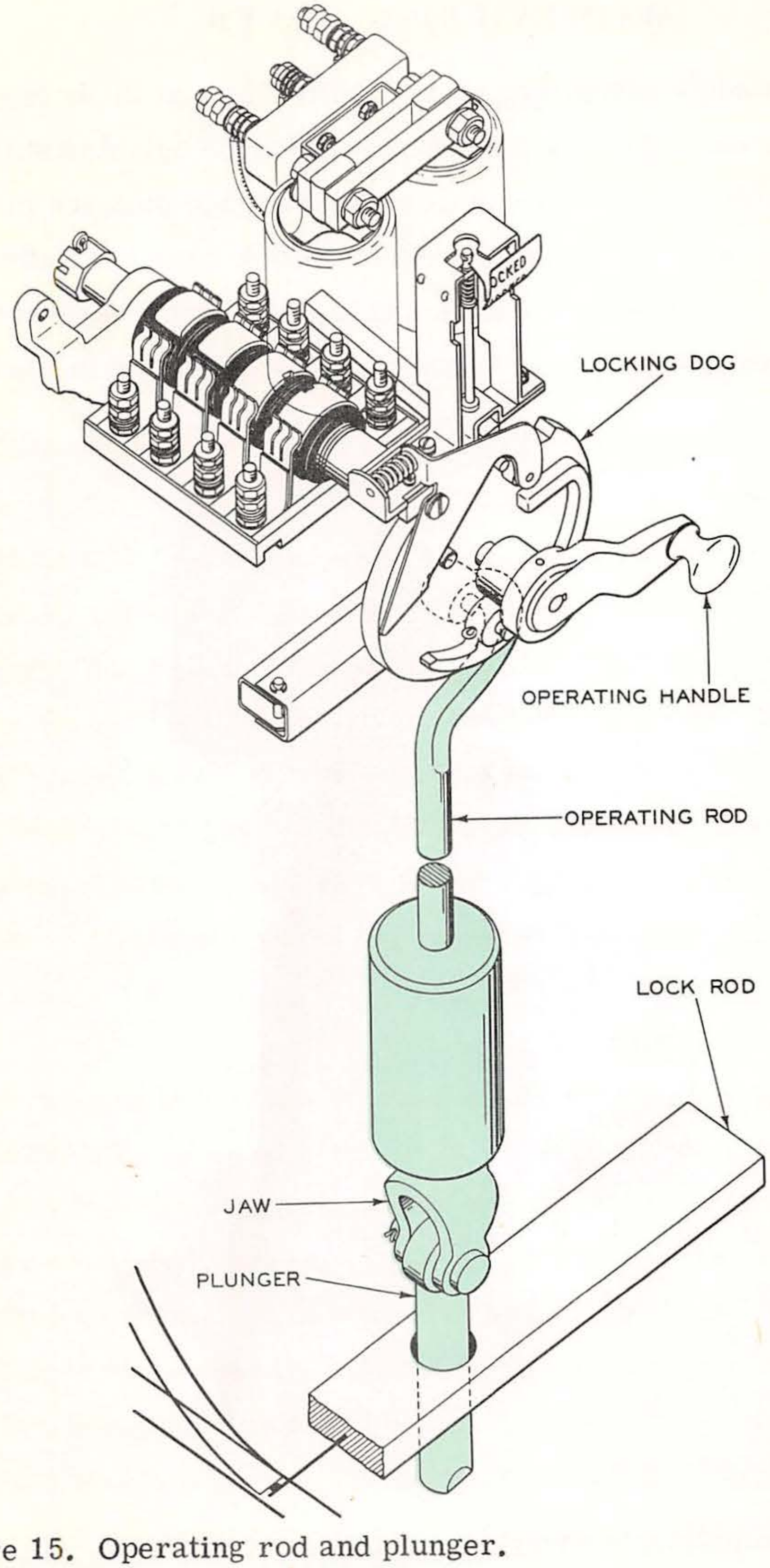

LOCKED
LOCKING DOG
OPERATING HANDLE
OPERATING ROD
LOCK ROD
JAW
PLUNGER

Figure 15. Operating rod and plunger.

LOCK AND MECHANISM

Parts and Operation

Figure 15 shows the complete Model 9B lock with all external parts taken away to expose the operating parts in their proper relationship. You can follow the operational sequence through on this drawing from the raising of the operating handle to the final return of the handle to its normal position after the switching operation has been carried out. A diagrammatic view of a track switch is included to show how the lock rod is moved by the switch points.

The parts of the lock are generally interchangeable. One mechanism will fit in place of another. The base for the high lock is the same as the base for the dwarf lock except that holes must be drilled and tapped in the high lock base for the case, mechanism, and maintainer's cover eyebolt hinges if it is intended to be used as a base for the dwarf lock. Coils may be changed to change the operating voltage to another value. Operating voltages are 2, 8, 10 or 12 volts. Where a lock is required to operate on alternating current, a BQ-1/2 rectifier can be used to supply rectified A. C.

Operating Rod and Plunger

The operating rod, Figure 15, is a goose-necked rod which connects the locking dog with the plunger. It is designed to pick up the plunger when the operating handle is moved to its 180 degree full reverse position. It forces the plunger back down into its hole in the lock rod on the return stroke of the handle. A weight is attached to the lower part of the operating rod to assist the operating handle in returning the plunger to the lock rod hole. The weight rests on a jaw which is pinned to the operating rod. At the lower end of the jaw is a pin which makes a swivel connection with the locking plunger. Therefore at any position of the operating rod the locking plunger will move vertically in its guide holes. The locking plunger is 1 inch in diameter and fits into a hole in the lock rod.

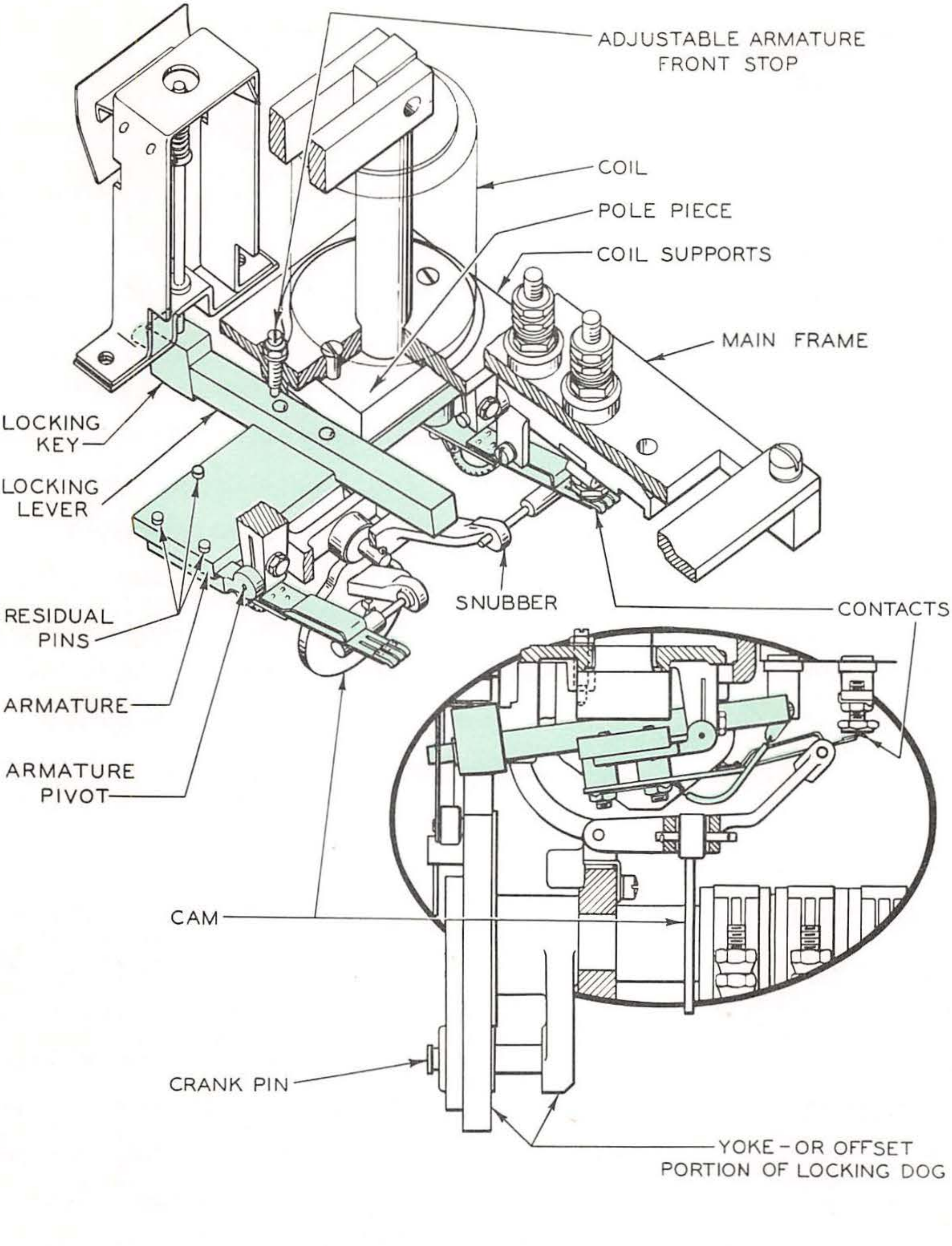

ADJUSTABLE ARMATURE FRONT STOP
COIL
POLE PIECE
COIL SUPPORTS
MAIN FRAME
LOCKING KEY
LOCKING LEVER
RESIDUAL PINS
ARMATURE
ARMATURE PIVOT
SNUBBER
CONTACTS
CAM
CRANK PIN
YOKE - OR OFFSET PORTION OF LOCKING DOG

Figure 16. Parts of mechanism cut away to show armature assembly and related parts.

Coils and Magnetic Structure

Figure 16 shows the coils and magnetic structure of the Model 9B lock. The pole pieces (only one shown) are fastened to the magnet support so that the pole pieces are directly over the armature. An adjustable armature front stop limits the travel of the locking lever. Terminal posts (not shown) are on top of the coils in a horizontal position, easy to get at. Coils are supplied for operation at 2, 8, 10 or 12 volts.

Operating Values

Volts Direct Current	Amps. Operating Current	Ohms Lock Coil Resistance
2	.091	16
8	.030	200
10	.024	306
12	.024	400

Volts A.C.	Amps. D.C.	Ohms	BQ 1/2 Rectifier Ordering Reference
110 V 60-cy.	.024	306	Plate P1787 Fig. B5
110 V 25-cy.	.024	306	Plate P1787 Fig. B6

Note: For 110 V current supply, either 60-cy. or 25-cy. order a 10-volt lock with one of the BQ 1/2 rectifiers shown above.

Armature and Locking Key

The locking key, in its locked position, holds the locking dog and attached operating handle from moving beyond the 45 degree preliminary unlock position. The round portion of the locking lever extending beyond the locking key is acted upon by the force-down feature of the lock.

Two independent contacts attached to the armature are an optional feature shown in Figure 16. These contacts are made when the lock is deenergized and the armature is down. A snubber which is pivoted to a bracket on the frame rides up on a cam keyed to the main shaft when the handle is returned to the normal or 0 degree position. The arms on the snubber prevent the contacts from opening due to vibration.

The armature has six residual pins in its face.

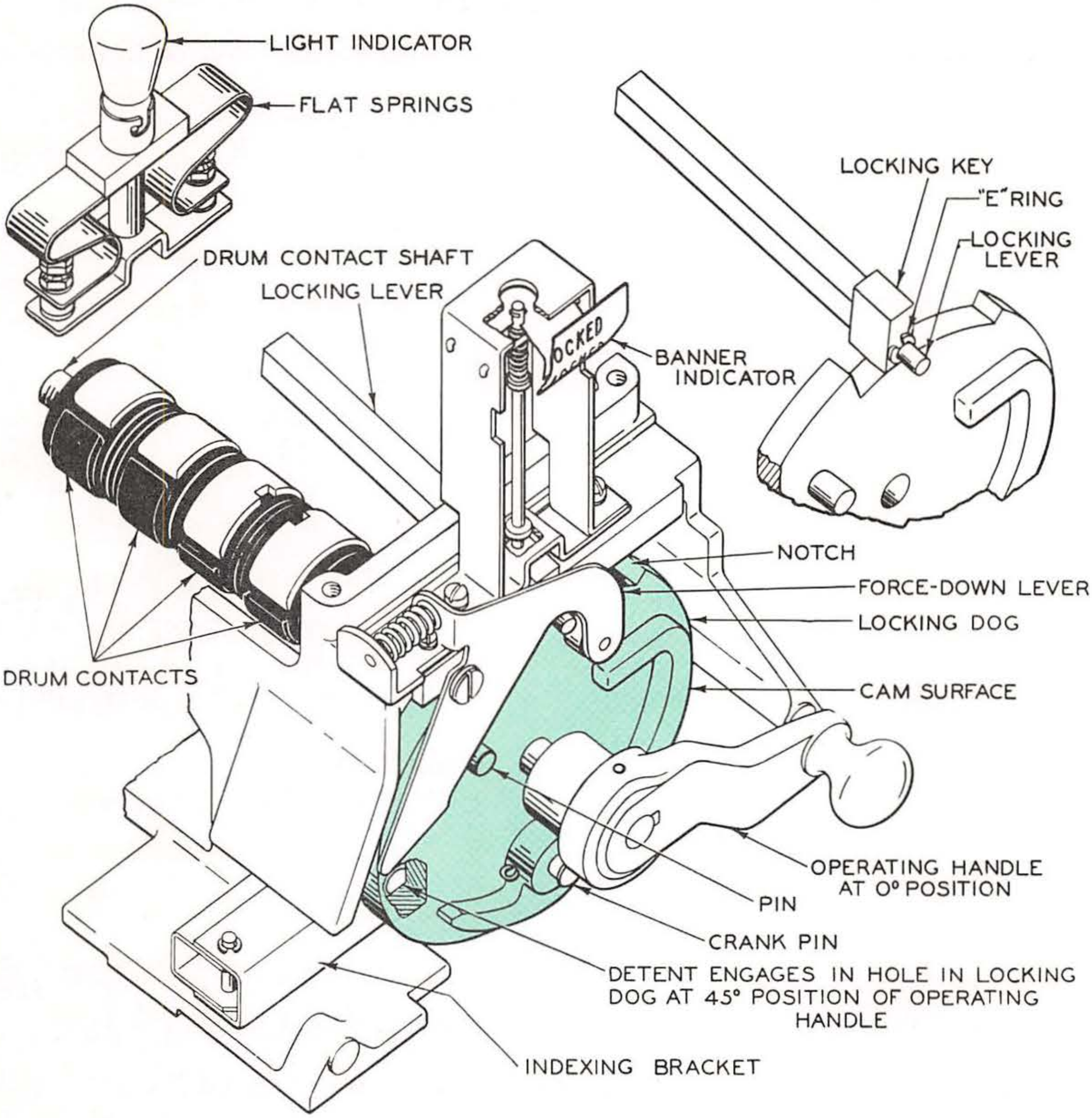

LIGHT INDICATOR
FLAT SPRINGS
LOCKING KEY
"E" RING
LOCKING LEVER
DRUM CONTACT SHAFT
LOCKING LEVER
BANNER INDICATOR
NOTCH
FORCE-DOWN LEVER
LOCKING DOG
CAM SURFACE
DRUM CONTACTS
OPERATING HANDLE AT 0° POSITION
PIN
CRANK PIN
DETENT ENGAGES IN HOLE IN LOCKING DOG AT 45° POSITION OF OPERATING HANDLE
INDEXING BRACKET

Figure 17. Locking dog and related parts.

Locking Dog and Operating Handle

The locking dog, Figure 17, is a circular casting keyed to the main shaft just behind the operating handle and the partition. The dog has an offset portion or yoke, Figure 16. The bearing of the goose-necked operating rod, Figure 15, is fitted to the crank pin in the yoke so that when the handle is moved, the operating rod moves also. The locking dog has a pin and a cam surface on its front face which are used in connection with the force-down feature. The dog has a notch machined in its upper surface in which the locking key engages to prevent the lock from being operated. This locking key must be raised by the lock magnet before the handle can be operated to unlock the switch.

An indexing bracket, Figure 17, is mounted behind the locking dog. This bracket forces a spring-loaded catch into a detent on the back of the locking dog when the handle is at the 45 degree position, thus holding the handle and locking dog in this position.

Operation

A positive force-down lever, Figure 17, insures that the locking key is down in the notch of the locking dog. This is commonly referred to as the "forced-drop" feature. This is a pivoted, goose-necked lever. The goose-necked end of the lever is equipped with a roller which engages a cam built into the face of the locking dog. Until the handle is in the 45 degree position, a pin on the left side of the locking dog prevents the lever from raising to allow the locking key to lift out of the notch. As the operating handle is raised to the 45 degree position, the roller on the force-down lever engages the cam on the face of the locking dog and lifts enough to allow the locking key to clear the notch in the dog. As this is going on, the pin on the left face of the locking dog has moved down to clear the tapered portion of the force-down lever, thus releasing it just before the roller engages the cam and

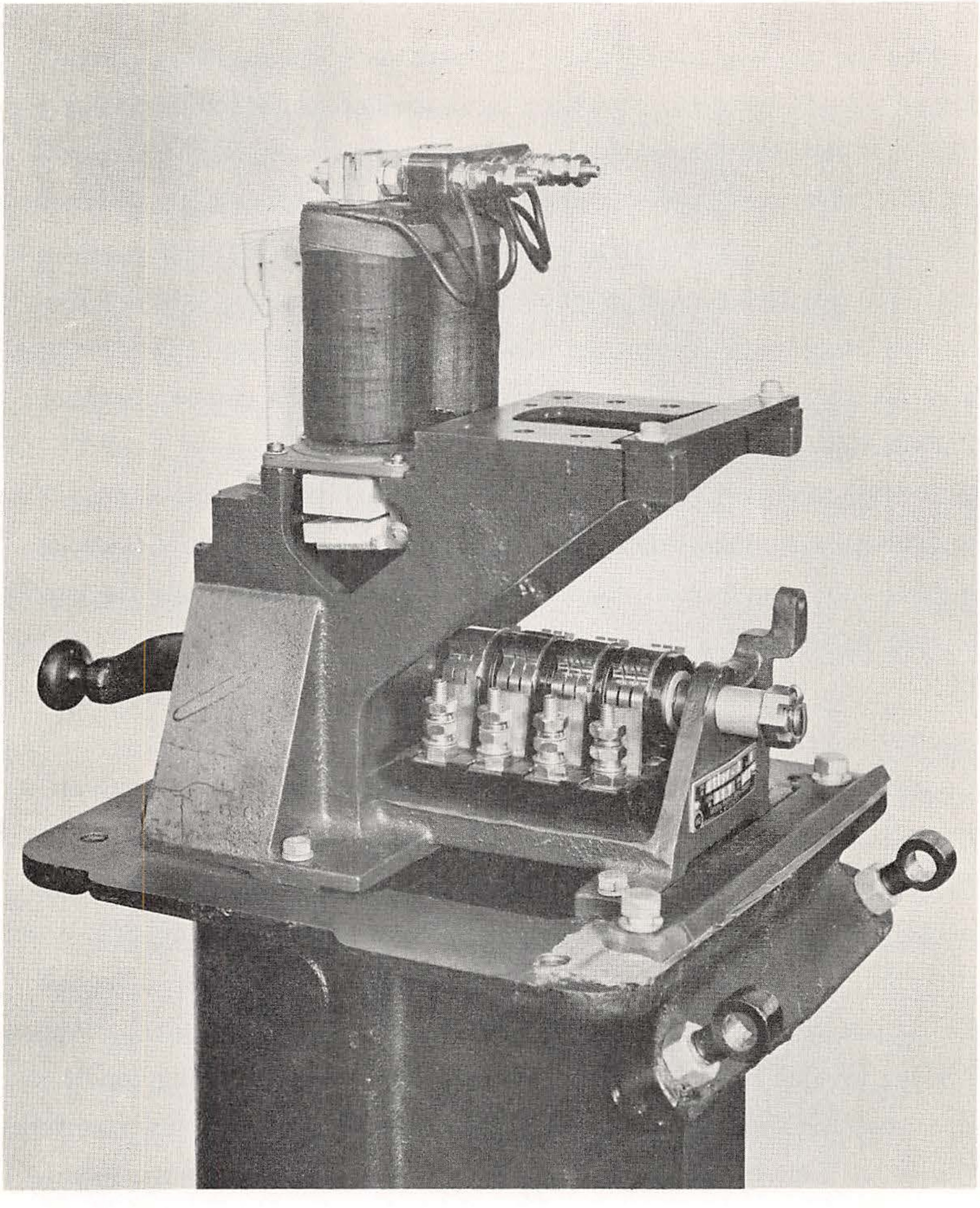


Figure 18. The case can be removed without disturbing the mechanism.

starts to lift the lever. When the armature is pulled up by the magnetic force of the energized coils, the force-down lever is already up to allow the key to be raised out of the notch.

Indicators

A banner type indicator, Figure 17, is a mechanical arrangement sturdily built to withstand shock and vibration and requires no extra energy for its operation. The banner indicator is operated by the locking key through a push rod, which is not directly connected to the locking dog and has a spring to take up any overtravel. Near the lower end of the push rod is a collar which supports the push rod free of the locking key until the locking key has started to rise. This relieves the armature of any load in the deenergized position. When the key is lifted, the push rod elevates the metal banner to show the word ''UNLOCKED'' through the window in the partition, Figure 10. On locks having the banner type indicator, it is necessary to operate the handle through the preliminary movement of approximately 45 degrees to permit the armature to pick up and actuate the indicator. All locks equipped with the banner type indicator have a plate inscribed ''Move lever here and wait for unlock''. This plate is located on the partition at the 45 degree position.

A light indicator, Figure 17, can be furnished instead of the banner indicator for railroads who wish to have a visual indication without requiring the operation of the handle through the preliminary movement. The lamp is spring mounted to withstand shock and vibration. Either indicator may be attached at the same location on the lock - directly above the locking key.

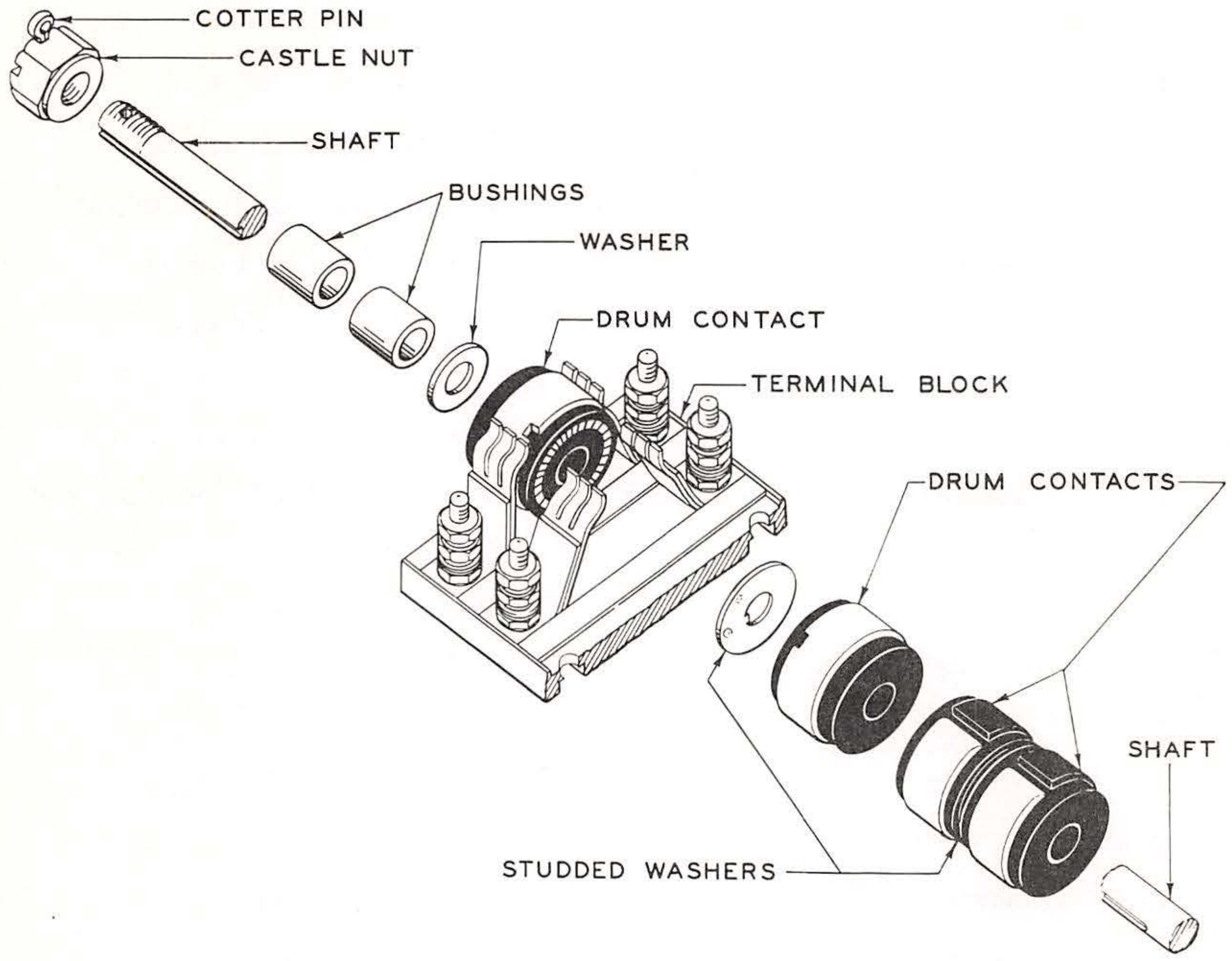

COTTER PIN
CASTLE NUT
SHAFT
BUSHINGS
WASHER
DRUM CONTACT
TERMINAL BLOCK
DRUM CONTACTS
SHAFT
STUDDED WASHERS

Figure 19. Exploded view of drum contact assembly.

Drum Contacts

Four adjustable drum contacts on the rear of the main shaft, Figure 19, can be adjusted to make or break in any position of the 180-degree throw of the handle. Usually they are adjusted so that two are closed in the normal or 0-degree position of the handle and the other two close at the 45-degree position. These drum contacts are molded with a circle of rectangular openings 12 degrees apart on one side only as shown in Figure 19. A studded washer is placed between each two contacts. The studded washer has a key which fits into a keyway milled on the shaft. Because the drum contacts are engaged on the studs of this washer they are turned by the movement of the main shaft.

Contact adjustment is made by loosening the nut at the end of the shaft and sliding the bushings back enough to disengage the drum contacts from the studded washer. Now shift the drum contacts to the desired position and put them back in contact with the studded washers. Do this two at a time, starting from the back. Replace the outside washer and bushings. Tighten the nut till the whole assembly is snug; then replace the cotter pin.

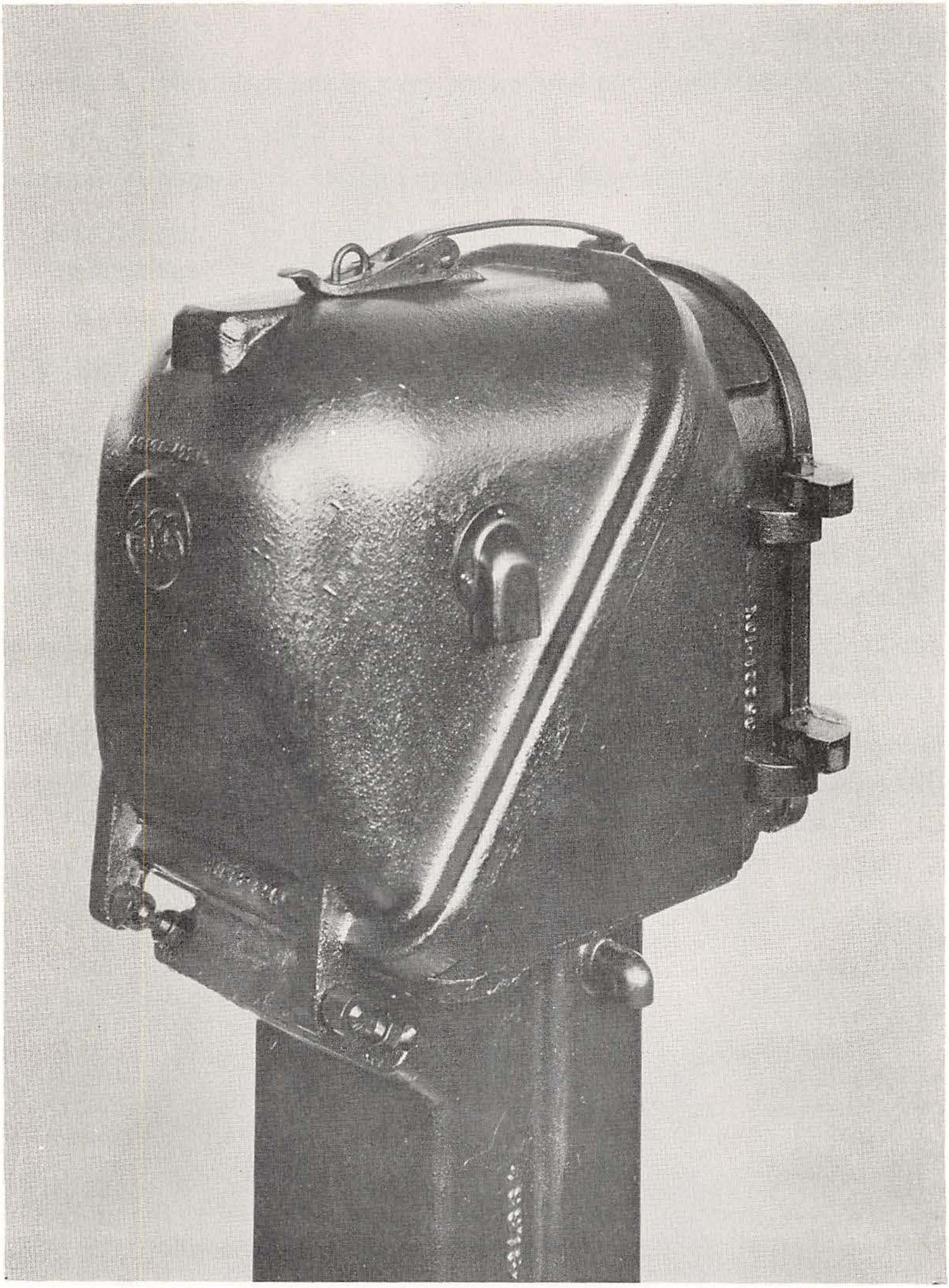


Figure 20. Rear view of lock.

OPTIONS

Light Indicator

The light indicator, Figure 17, is an optional feature which can be supplied when specified. The lamp socket is mounted on flat springs to minimize the effects of vibration. Directly under the lamp socket is an insulator which prevents the springs from being distorted when replacing the lamp.

Pushbutton

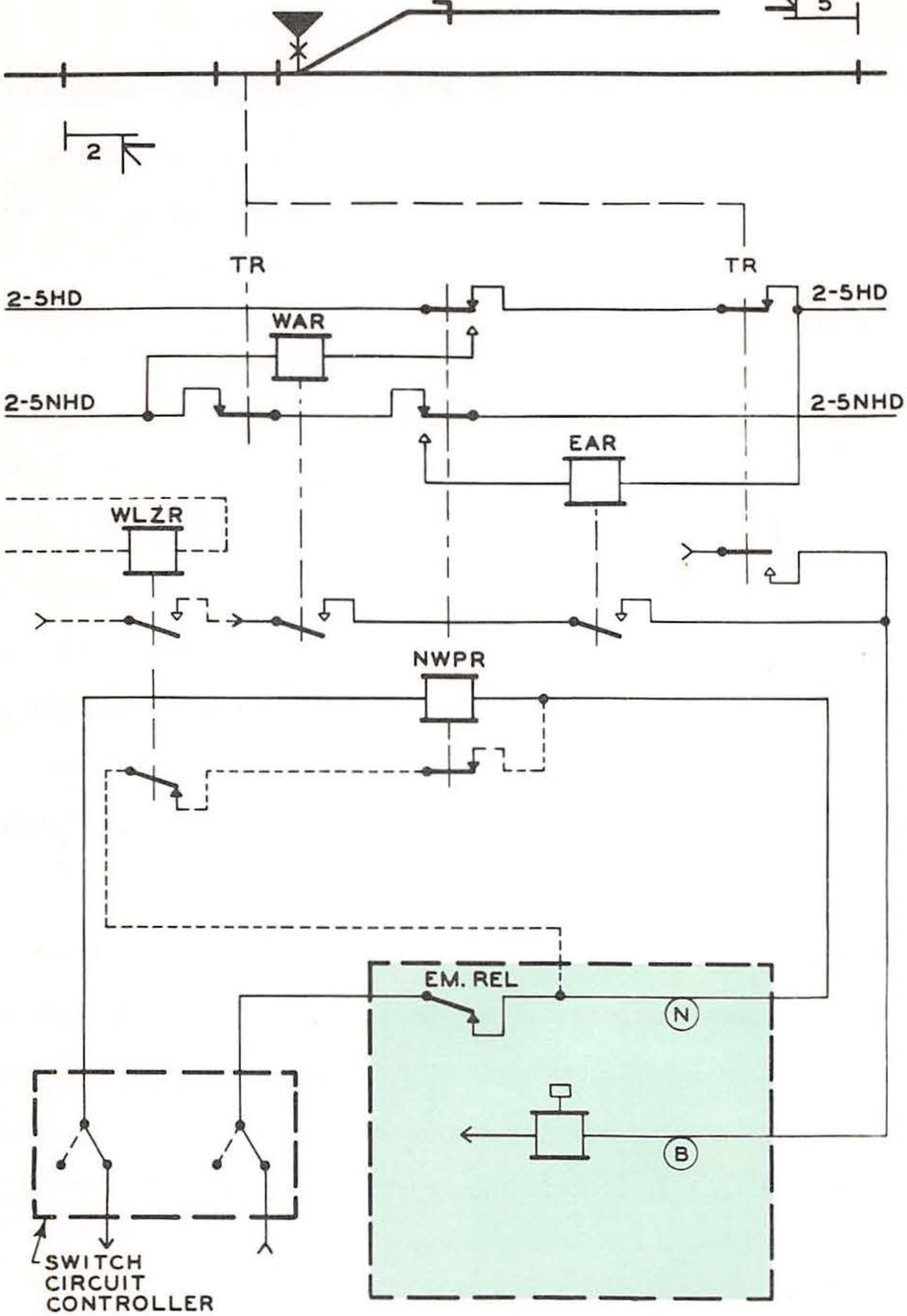
An auxiliary pushbutton can be provided for mounting on the case partition and has one normally closed contact or one normally open contact.

Door Circuit Controller

The door circuit controller can be provided for mounting on the case partition. Door circuit controllers are available with one independent normally open and one independent normally closed contact or with two independent normally open and two independent normally closed contacts.

Emergency Release

The emergency release is an optional feature. It fits on the left-hand side of the frame near the force-down lever. It is of the latch-out type, which requires resetting by someone other than a trainman. The release is equipped with one normally closed contact. This release is also normally sealed with wire seals. It is necessary to break the seal before it can be operated.



5
2
TR
TR
2-5HD
2-5HD
WAR
2-5NHD
2-5NHD
EAR
WLZR
NWPR
EM. REL
N
B
SWITCH
CIRCUIT
CONTROLLER

MODEL 9B SWITCH LOCK

Figure 21. Typical switch-lock control circuit with normally deenergized approach relays. Preliminary movement of crank will slot signals. Broken lines show optional supervisory control.

CIRCUITS

Figure 21 shows an arrangement having normally deenergized AR relays. This circuit is suitable for use on a two-, three-, or four-wire signal system (2-wire shown) with or without supervisory control.

Since AR relays are connected to the line through back contacts on the NWPR relay, the signal circuits will be opened by the preliminary movement of the operating handle. When supervisory control is used, the signal circuits will not be opened unless the supervisory control relay (WLZR) is energized and the operating handle is moved to the preliminary position.

The circuit as shown uses the mechanical emergency release. A short track circuit is used to release the lock when a train wishes to leave the main line. An indication, if required, would be taken from the NWPR relay.

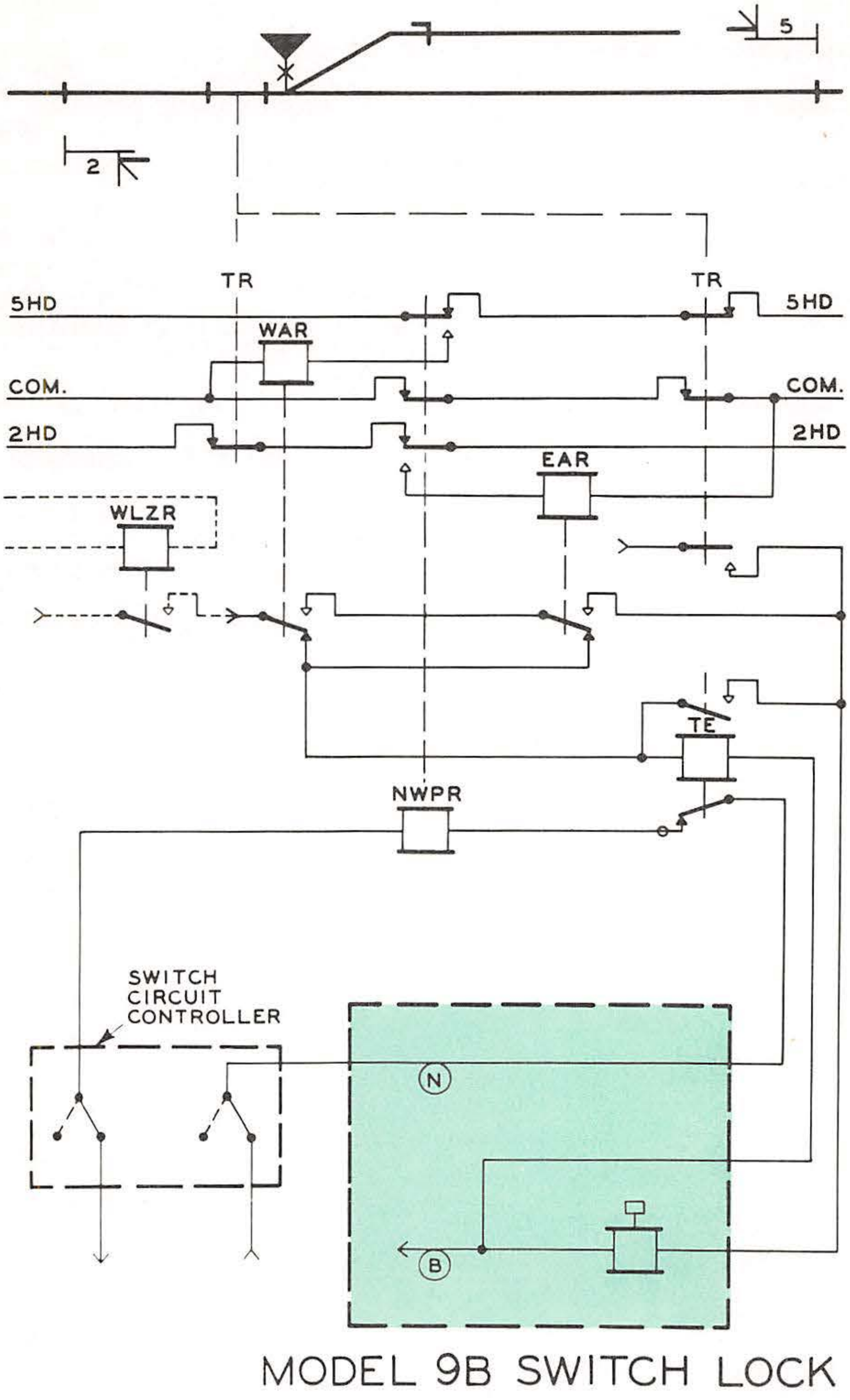
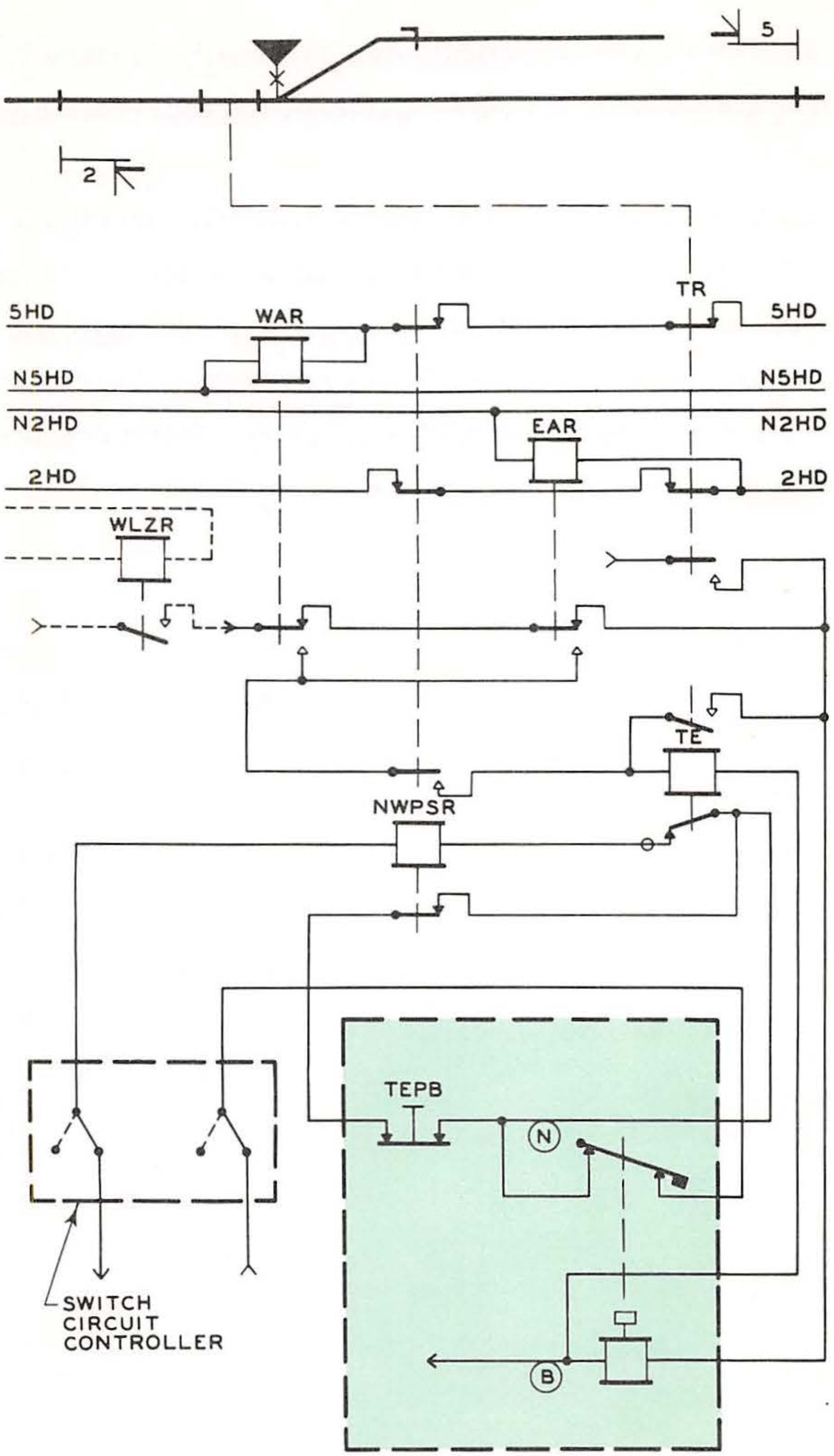

5
2
TR
TR
5HD
5HD
WAR
COM.
COM.
2HD
2HD
EAR
WLZR
TE
NWPR
SWITCH CIRCUIT CONTROLLER
N
B
MODEL 9B SWITCH LOCK

Figure 22. Typical switch-lock control circuit with emergency release and normally deenergized approach relays. Broken lines show optional supervisory control.

Figure 22 shows an arrangement having normally deenergized AR relays. This circuit is suitable for use on a two-,three -,or four-wire signal system (3-wire shown).

The preliminary movement of the crank will open the signal controls, dropping the NWPR relay. The circuit can be used either with or without supervisory control. The circuit is shown with an automatic electrical time release. Release track for leaving the main line is indicated. An indication, if required, would be taken from the NWPR relay. The mechanical emergency release can be used in addition, if desired.


5
2
TR
5HD
WAR
5HD
N5HD
N5HD
N2HD
EAR
N2HD
2HD
2HD
WLZR
TE
NWPSR
TEPB
N
B
SWITCH
CIRCUIT
CONTROLLER

MODEL 9B SWITCH LOCK

Figure 23. Typical switch-lock control circuit with pushbutton and normally energized approach relays. Broken lines show optional supervisory control.

Figure 23 shows an arrangement having normally energized WAR and EAR relays and is suitable for a four-wire signal system only. This circuit has one feature in that neither the energization of supervisory control nor the preliminary movement of the crank will slot the signals if a train is approaching the location. This circuit requires the use of an armature contact on the lock mechanism to drop the NWPSR relay as soon as the lock is energized. The circuit as shown contains a time relay which will release the locking after a predetermined time interval, if either approach is occupied. Timing will not start until after the deliberate operation of the TE pushbutton in the lock, which will drop the NWPSR and slot the signals. A short track circuit is used to release the lock for a train leaving the main line. If desired, this can be made dependent upon the supervisory control, which itself is optional. If an indication is required in the case of supervisory control, it would be taken from the NWPSR relay.

HOW TO ORDER

The standard lock is furnished with:

1. Open-type base
2. Banner indicator
3. Drum contacts (factory adjusted with two closed in normal position and two open in normal position which close at the 45 degree position).

* * *

When ordering a lock, please specify the following:

1. Height (22-1/2", 30-1/2", 38-1/2", or 43-1/2"), dimension "A", Figure 2.
2. Distance from gauge of near rail, dimension "B", Figure 2.
3. Whether open-type base will be used with:
    a. single lock rod
    b. double lock rod
4. Lock rods are not furnished with the open-type base unless specified. Single or double adjustable lock rods may be supplied with either tang or threaded ends. When ordering lock rods, please specify which is desired. Also specify the distance from the center of the locking hole to the center of the coupling on tang end lock rods or to the end of the thread on threaded lock rods. Single lock rods will be drilled for closed point only unless otherwise specified.
5. Coil voltage (2, 8, 10 or 12 volts). See table of operating values on page 23.

These locks may also be ordered with any of the following optional features:

1. Watertight base (furnished with single lock rod only). Please specify whether lock rod is desired with tang or threaded end. Also specify whether lock rod is for normally open or normally closed point. Lock rod is included with the watertight base.
2. Junction box (for locks mounted on concrete bases).
3. Light indicator.
4. Door circuit controller with one independent normally open and one independent normally closed contact or with two independent normally open and two independent normally closed contacts. Specify which.
5. Pushbutton with one normally closed contact or one normally open contact. Specify which.
6. Drum contact (two standard and two slip contacts with 45 degree lost motion).

7. Independent armature contacts. Two independent contacts, closed when lock is deenergized, can be provided, if specified.
8. Emergency release equipped with one normally closed contact.

G-R-S NEWS

January 1953

In this issue:

G-R-S Adjustable Cases

58271

-1 LDD
-2 HSD
-3 HDD

G-R-S ADJUSTABLE CASES

Purpose

New sheet metal cases in four standard sizes have been designed to facilitate shipments and will be produced this year. These cases will be carried in stock for immediate delivery. Because these cases are carried in stock, changes for individual railroads cannot be considered. If special shop work is desired, delivery will be based on manufacture from plans and factory orders. Cases will not be brought back into the factory from stock for further processing. The 56101 types will be furnished for special orders.

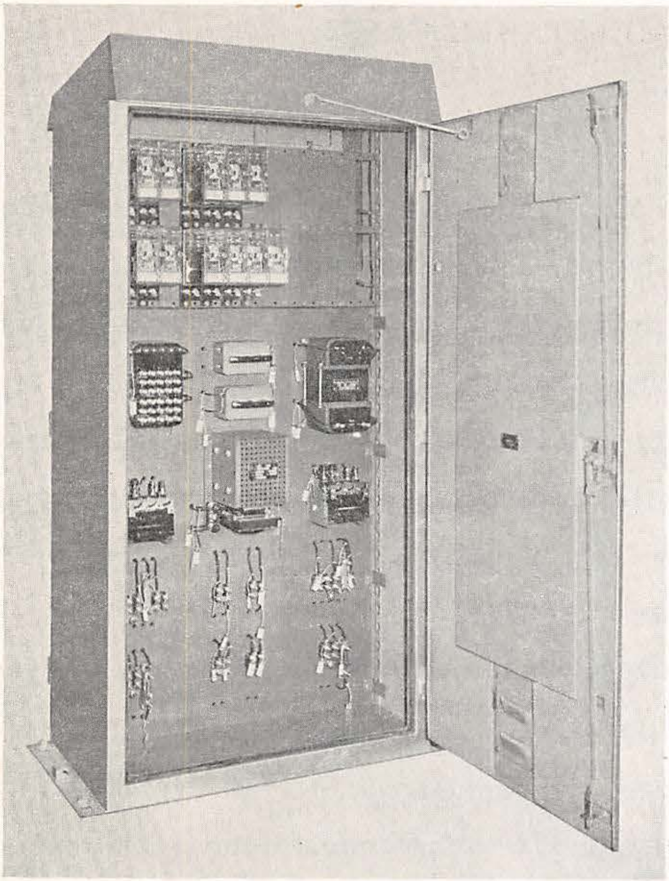
These cases will be manufactured with permanently installed keyhole channels on both sides. The purpose is to provide flexibility in the arrangement of relays, shelves, and backboards.

All double door cases have a 3-3/4-inch vertical center jamb separating the doors and against which the doors close. Behind this jamb are welded two vertical keyhole posts for supporting shelves which may be moved up and down in increments of 2-13/64-inches.

All cases are now 24 inches deep. It will be noted that this case is one inch deeper than any case previously manufactured.

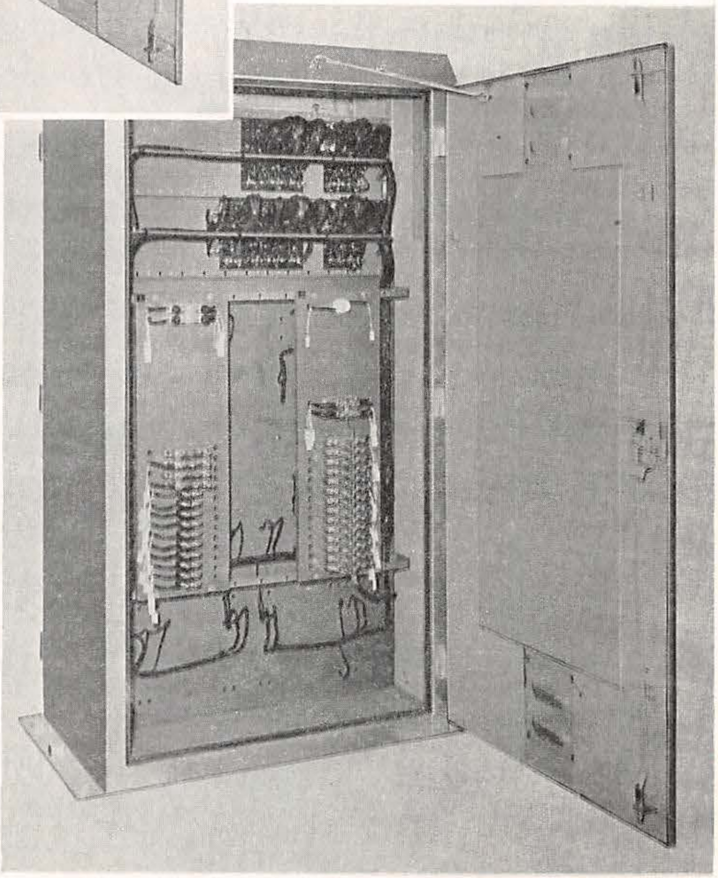
Maximum interchangeability of accessories is planned.

Four Sizes	Overall Dimensions	
	Width	Height
Low single case (Figure 1)	38"	58"
Low double case (Figure 2)	75-3/4"	58"
High single case (Figure 3)	38"	78"
High double case (Figure 4)	75-3/4"	78"



Front view of case showing arrangement of relays and apparatus.

Rear view of case showing wiring of plugboards.



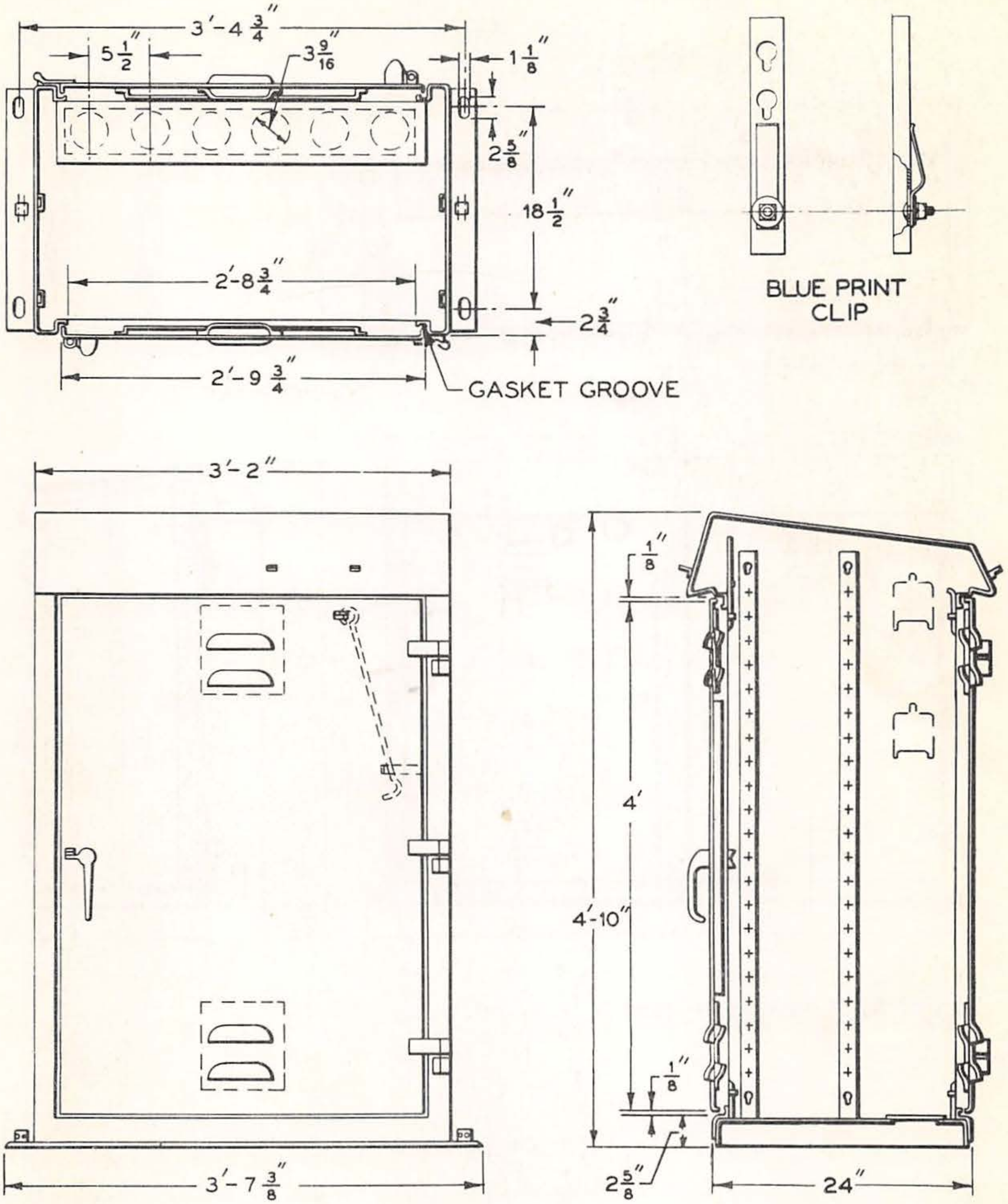

3′-4 3/4″
5 1/2″
3 9/16″
1 1/8″
2 5/8″
18 1/2″
2′-8 3/4″
2 3/4
2′-9 3/4″
GASKET GROOVE
BLUE PRINT
CLIP
3′-2″
3′-7 3/8″
1/8″
4′
4′-10″
1/8″
2 5/8″
24″

Figure 1. Low single case

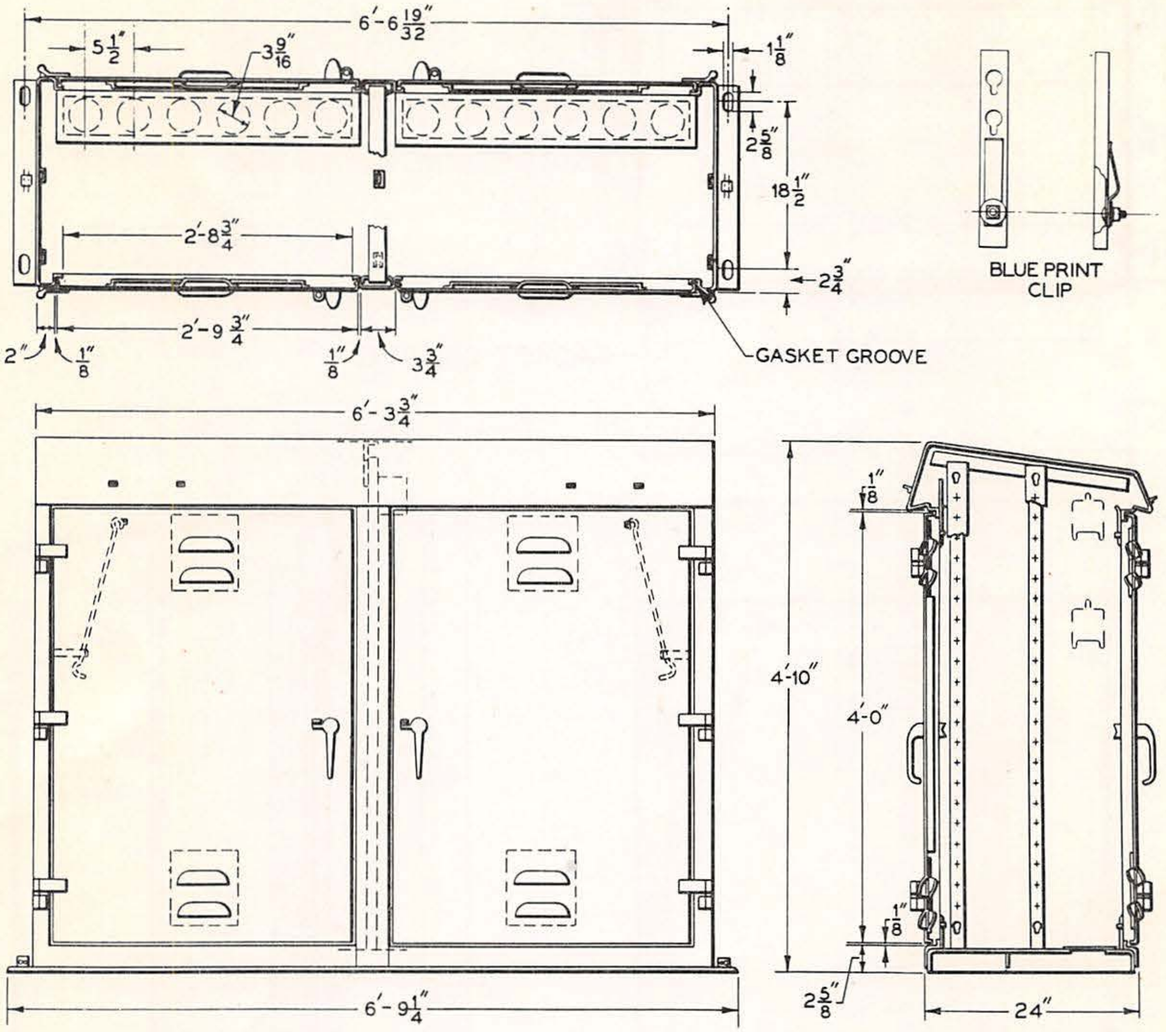

6'-6 19/32"
5 1/2"
3 9/16"
1 1/8"
2 5/8"
18 1/2"
2'-8 3/4"
2 3/4"
2'-9 3/4"
2"
1/8"
1/8"
3 3/4"
GASKET GROOVE
BLUE PRINT CLIP
6'-3 3/4"
4'-10"
1/8"
4'-0"
1/8"
2 5/8"
24"
6'-9 1/4"

Figure 2. Low double case

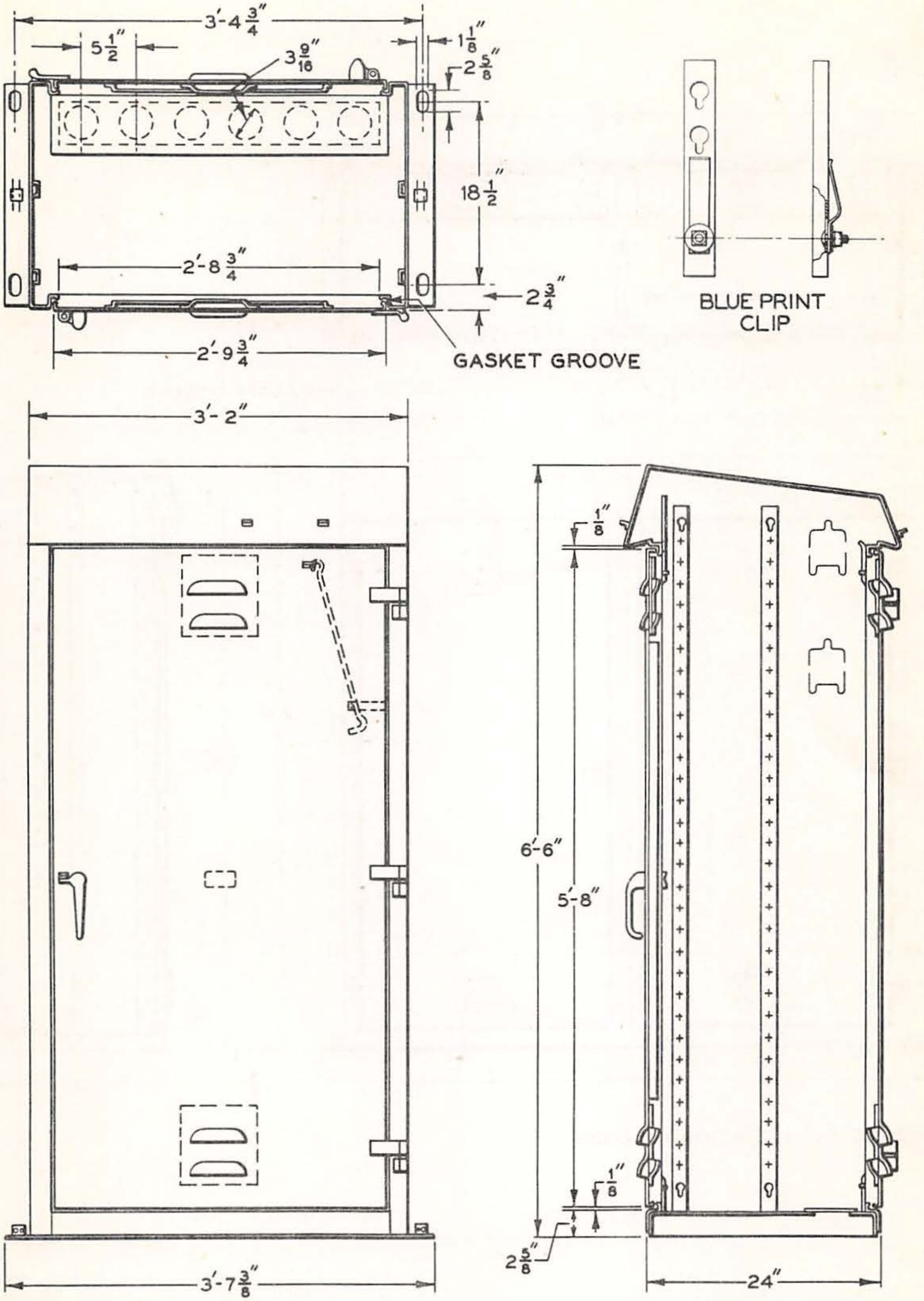

3'-4 3/4"
5 1/2"
1 1/8"
3 9/16"
2 5/8"
18 1/2"
2'-8 3/4"
2 3/4"
2'-9 3/4"
GASKET GROOVE
BLUE PRINT CLIP
3'-2"
6'-6"
1/8"
5'-8"
1/8"
2 5/8"
3'-7 3/8"
24"

Figure 3. High single case

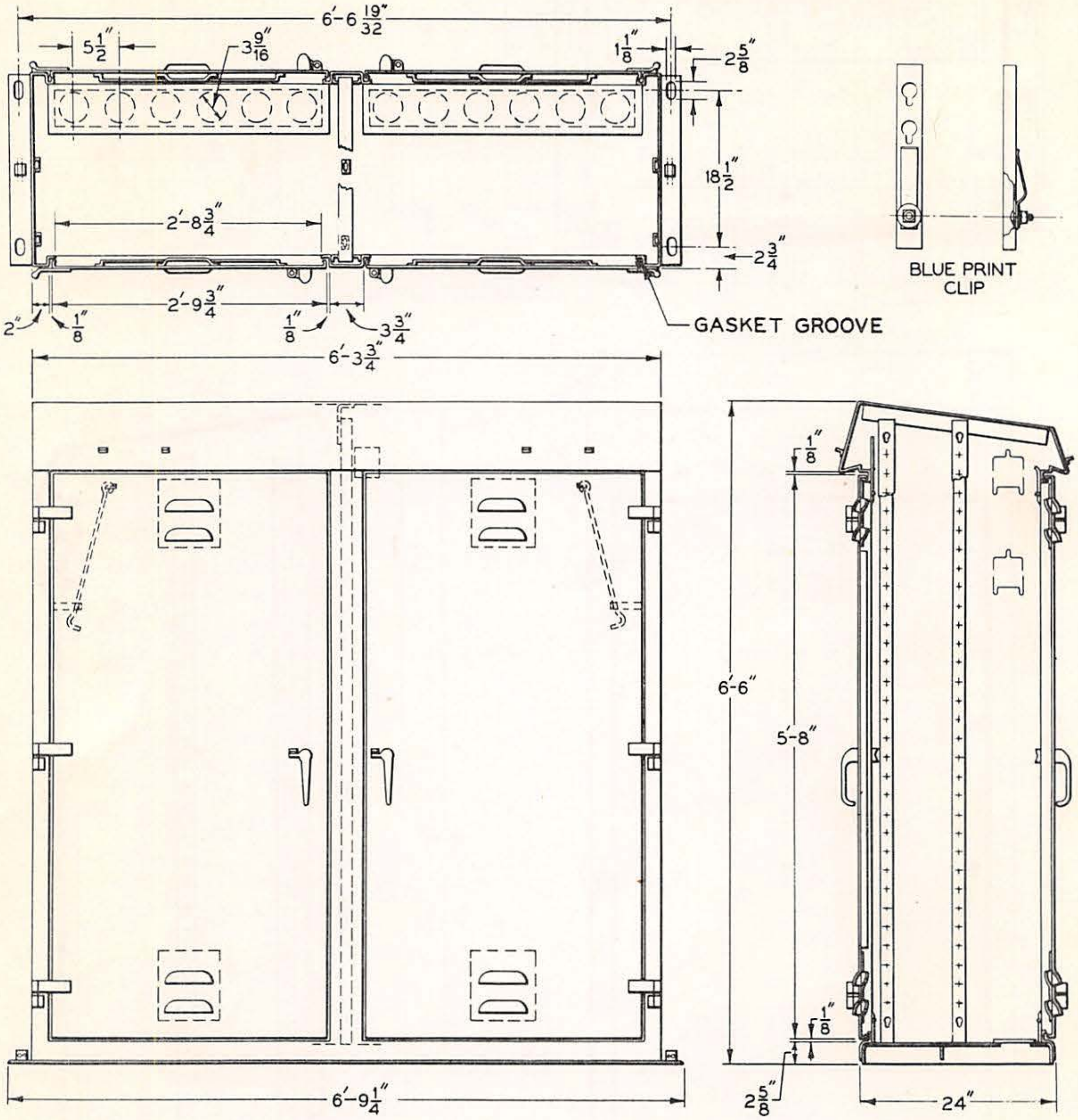

6'-6 19/32"
5 1/2"
3 9/16"
1 1/8"
2 5/8"
18 1/2"
2'-8 3/4"
2 3/4"
2'-9 3/4"
2"
1/8"
1/8"
3 3/4"
GASKET GROOVE
BLUE PRINT CLIP
6'-3 3/4"
1/8"
6'-6"
5'-8"
1/8"
2 5/8"
24"
6'-9 1/4"

Figure 4. High double case

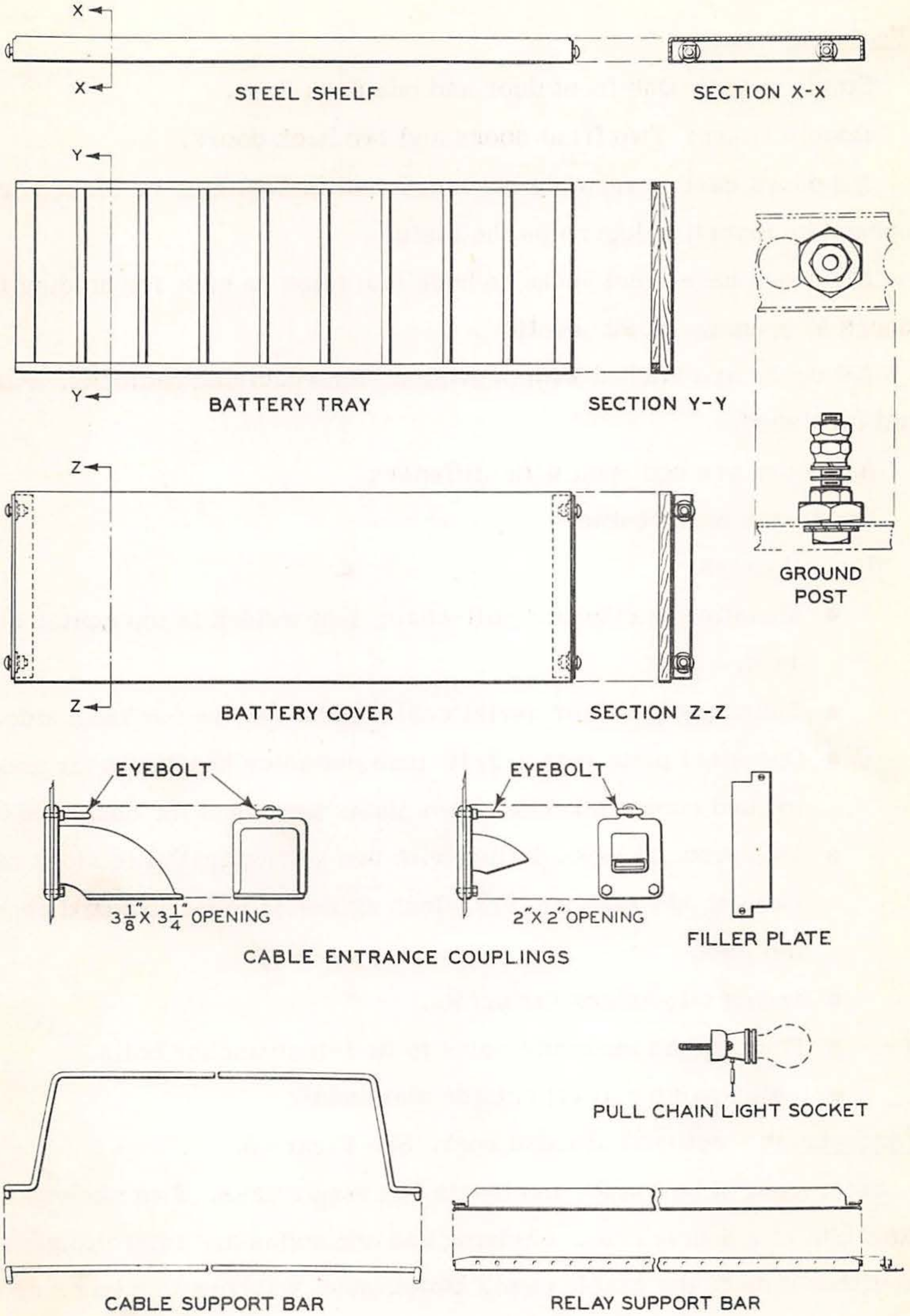

X
X
STEEL SHELF
SECTION X-X
Y
Y
BATTERY TRAY
SECTION Y-Y
GROUND POST
Z
Z
BATTERY COVER
SECTION Z-Z
EYEBOLT
EYEBOLT
$3\frac{1}{8}$" X $3\frac{1}{4}$" OPENING
2" X 2" OPENING
CABLE ENTRANCE COUPLINGS
FILLER PLATE
PULL CHAIN LIGHT SOCKET
CABLE SUPPORT BAR
RELAY SUPPORT BAR

Figure 5. Accessories

Features

Single cases: One front door and one back door.

Double cases: Two front doors and two back doors.

All doors have reversible screened ventilators; may be closed or opened by inverting louvre on the inside.

All doors have steel hooks to hook into clips on case for holding the doors at openings of 90° or 160°.

All doors are latched with provisions for receiving padlocks. Padlocks not furnished.

All doors are equipped with stiffeners.

Doors are replaceable.

For all cases:

- Mounting bracket for pull-chain light welded in top center under roof.
- Four knockouts for aerial cable entrances, two on each side.
- One steel plate with 3-9/16-inch diameter knockouts for underground cable entrance. Two plates furnished for double case.
- Two ground blocks drilled with two holes parallel to sides of case of 3/8-inch and 9/32-inch diameter to fit standard channel pins.
- Spring clip holder for prints.
- Four oblong mounting holes to fit 1-inch anchor bolts.
- Inside painted gray; outside aluminum.

Accessories - optional at extra cost. See Figure 5.

Steel shelf of one width and length fits single case. Two shelves span the width of a double case. Shelving and apparatus are interchangeable on either side of the double case. Bolts, nuts, washers in a bag shipped with shelf.

Battery tray is made of wood and painted with acid-resistant paint. Edge cleats are nailed in place and painted. Eight intercell cleats per battery tray are shipped in a bundle with nails.

Battery cover is made of plywood, and supported above battery by brackets shipped with cover.

Couplings for aerial cable entrances are available in two sizes: 2"x 2" opening or 3-1/8"x 3-1/4" opening. Bolts, including one eye bolt for fastening messenger, are shipped with each coupling.

Relay support bars are used for supporting the Type B relay plugboards.

Cable support bars are used for supporting the wire harness behind the B relay plugboards.

Filler plates are bolted on the relay support bars, one at each end of a row of plugboards.

One relay support bar is required initially if B relays are going to be installed in a single case, or in one half of a double case.

In addition, for each row of relays it will be necessary to order a kit comprising -

1 relay support bar

1 cable support bar

2 filler plates and their fastenings

Plugboard kits can be ordered from G-R-S Catalog Section E Part 31, Plate E3137.

The low single case has a maximum capacity of 60 B1 relays. The high single case has a maximum capacity of 84 B1 relays.

A typical arrangement is shown in Arrangement E.

Ground post 5/16-18 has hardened steel nut with serrated teeth which scrape the paint from the keyhole in which it is installed. It digs into the metal to insure a good ground connection when the nut is tightened in place.

Pull chain light socket (less bulb) bolts to the mounting bracket previously mentioned. Fastenings provided.

3/4-inch plywood backboards with mounting clips, adjustable forward and backward on 1-1/2-inch centers, are available in sizes to fit all cases. A full backboard will be supplied on cases which are ordered with both backboard and relay support bars. This backboard can then be cut off to suit the particular installation.

Celotex lining - optional at extra cost.

Typical Arrangements for Low Single Cases

Arrangement A	Two steel shelves.
Arrangement B	One tray and one cover for batteries.

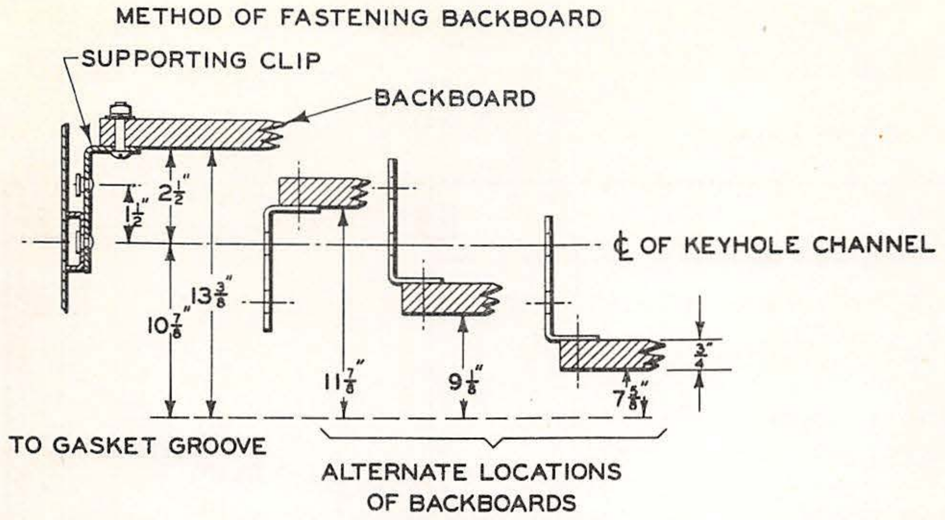
Typical Arrangements for High Single Cases

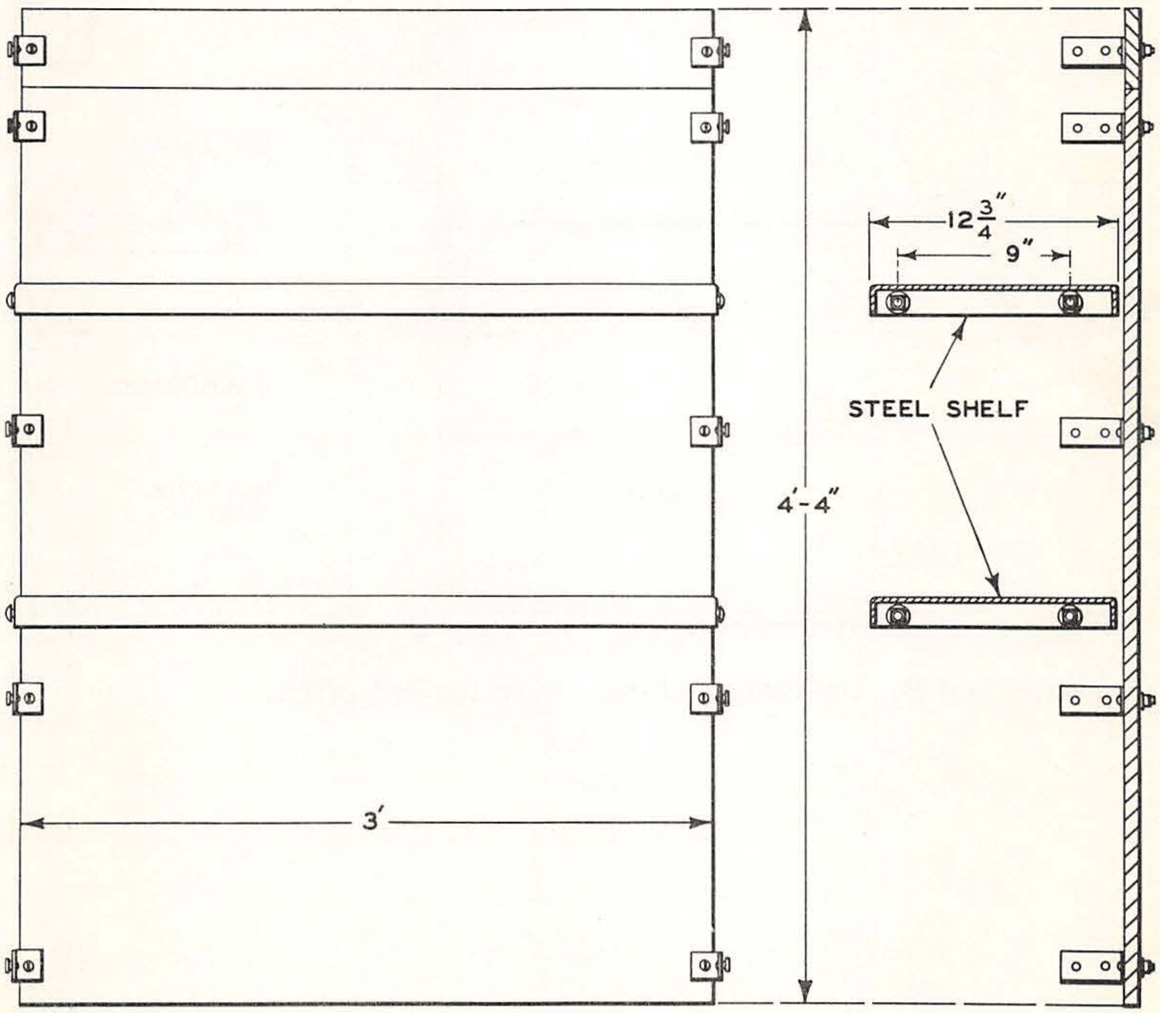
Arrangement C	Three steel shelves.
Arrangement D	One steel shelf, two trays and one cover for batteries.

Arrangements for double cases can be any combination of those shown above for single cases.

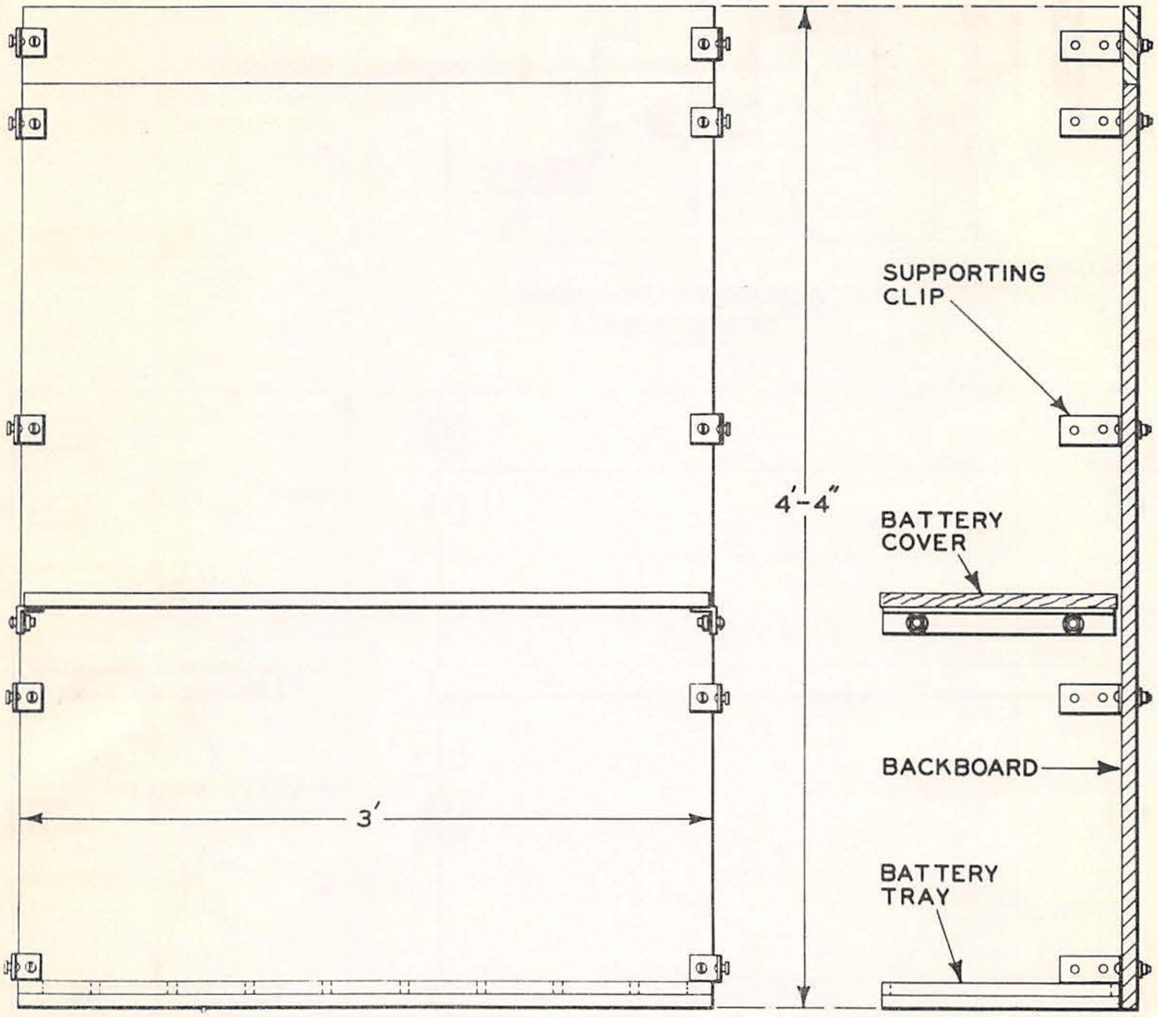
Typical Arrangement of B relays

Arrangement E	Type B plug-in relays.

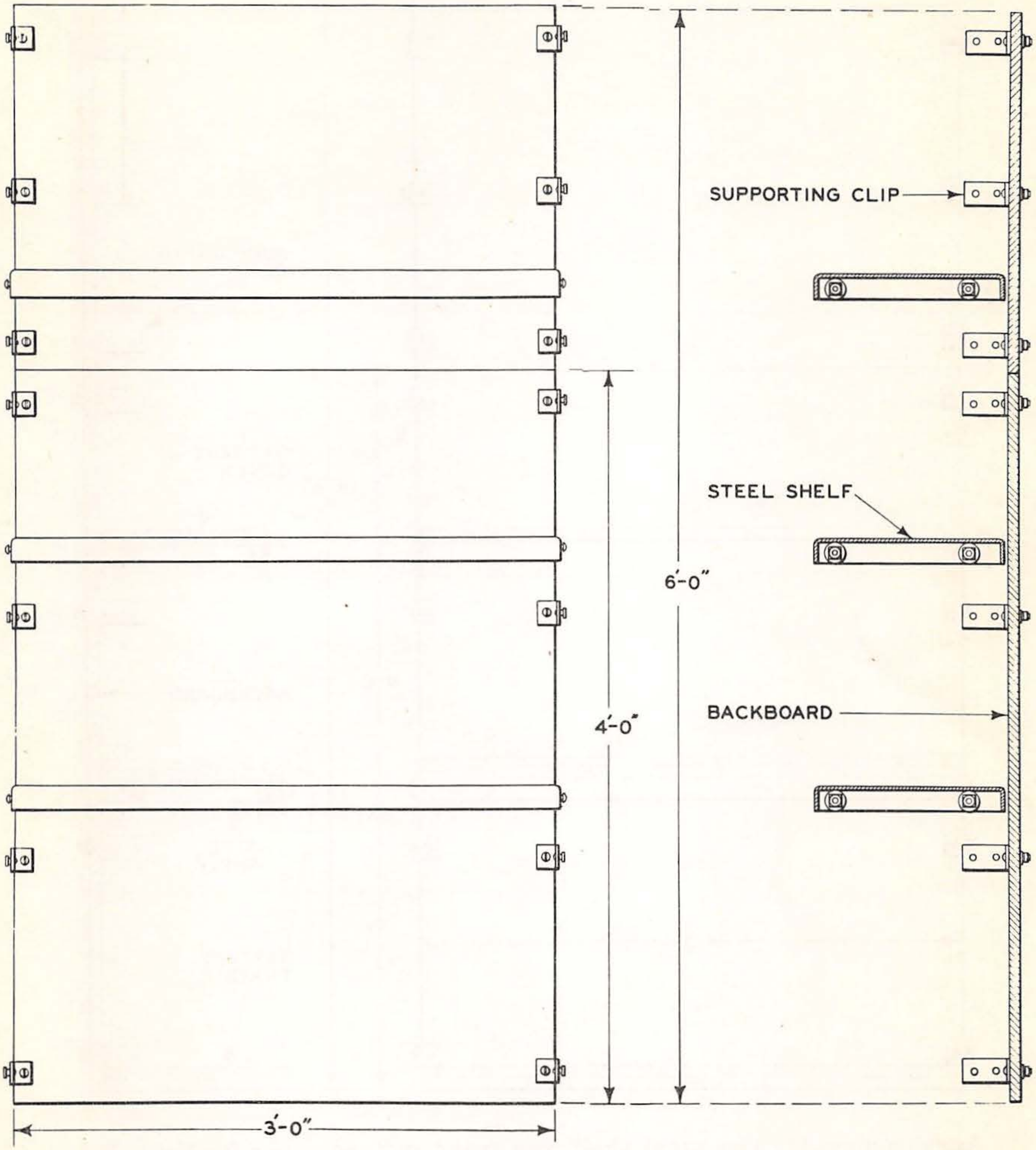

METHOD OF FASTENING BACKBOARD
SUPPORTING CLIP
BACKBOARD
2½"
1½"
13⅜"
10⅞"
11⅞"
9⅛"
7⅝"
¾"
℄ OF KEYHOLE CHANNEL
TO GASKET GROOVE
ALTERNATE LOCATIONS OF BACKBOARDS


12¾"
9"
STEEL SHELF
4'-4"
3'

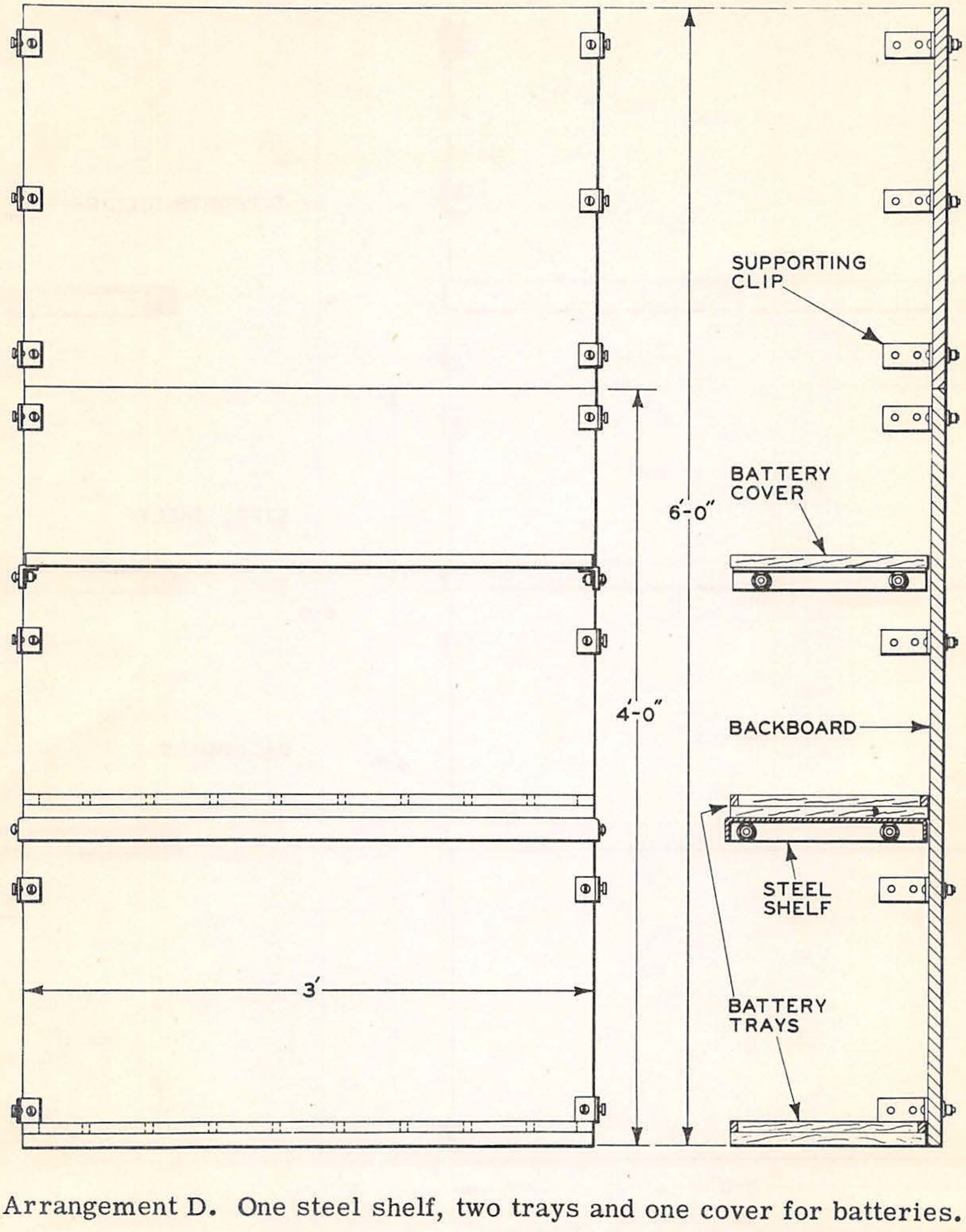
Arrangement A. Two steel shelves.


SUPPORTING CLIP
4'-4"
BATTERY COVER
BACKBOARD
3'
BATTERY TRAY

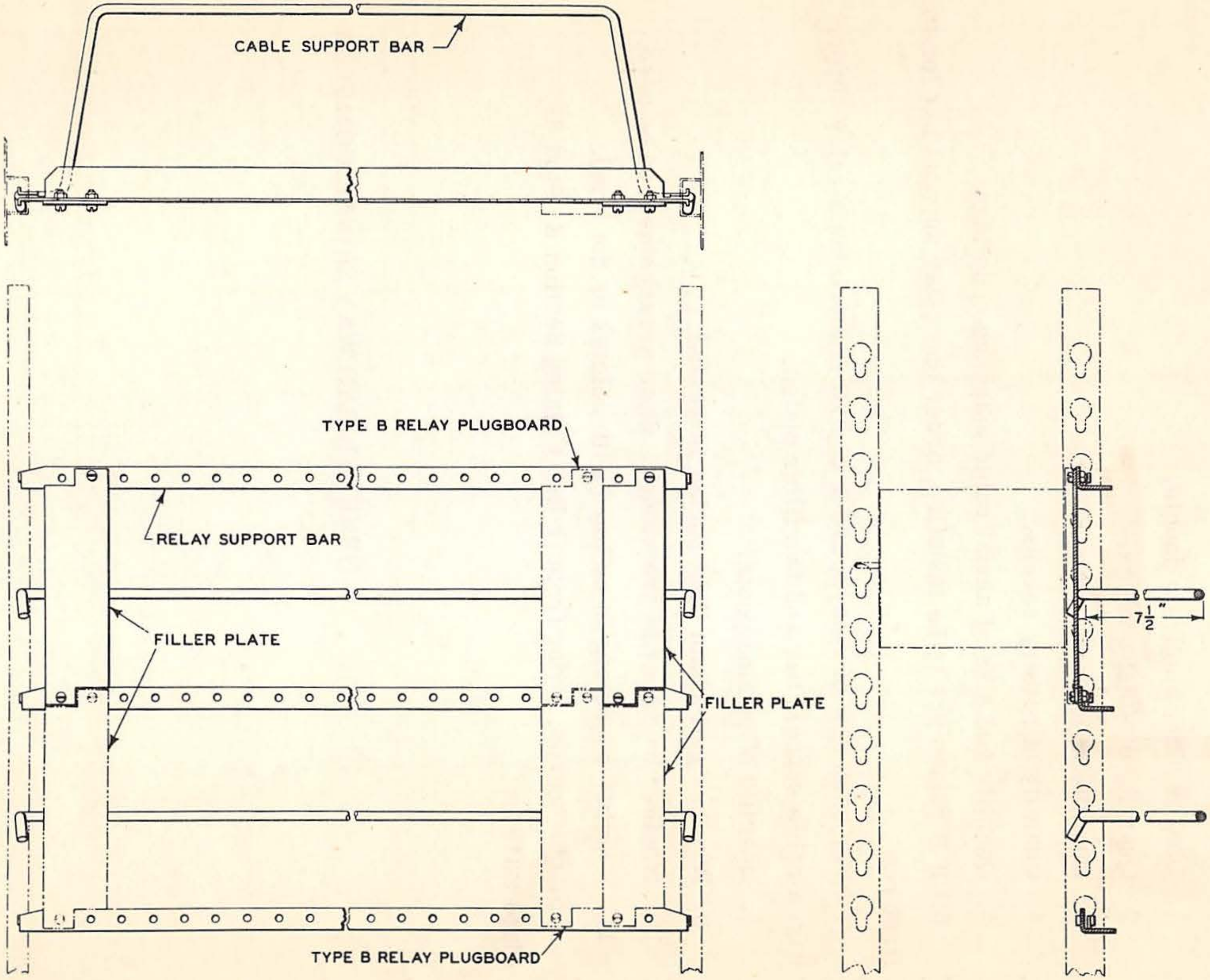
Arrangement B. One tray and one cover for batteries.


SUPPORTING CLIP
STEEL SHELF
BACKBOARD
6'-0"
4'-0"
3'-0"

Arrangement C. Three steel shelves.


SUPPORTING CLIP
BATTERY COVER
6'-0"
4'-0"
BACKBOARD
STEEL SHELF
BATTERY TRAYS
3'

Arrangement D. One steel shelf, two trays and one cover for batteries.


CABLE SUPPORT BAR
TYPE B RELAY PLUGBOARD
RELAY SUPPORT BAR
FILLER PLATE
FILLER PLATE
7½"
TYPE B RELAY PLUGBOARD

Arrangement E. Type B plug-in relays.

Ordering Information

Specify:

1. Low or high, single or double.
2. Quantity of steel shelves.
3. Quantity of battery trays.
4. Quantity of battery covers.
5. Quantity and size of aerial cable entrance couplings.
6. If B relays are to be installed, order one relay support bar for the first row.
7. For each row of relays, order one kit comprising a relay support bar, a cable support bar and two filler plates.
8. Quantity of ground posts.
9. Whether pull-chain light socket is wanted.
10. Whether backboards are wanted. State arrangement to be used.
11. Whether cases are to be lined with celotex or not lined.

For plugboards, order from G-R-S Catalog Section E, Part 31, Plate E3137.

GENERAL RAILWAY SIGNAL COMPANY

G-R-S NEWS
December 1951

In this issue:

New Type K Lamp Control Relay
Dynamic Snub Circuit for Switch Machines
Standard Syncrostep Systems
1951 G-R-S News Index

NEW TYPE K LAMP CONTROL RELAY

A new Type K lamp energy control relay has been developed for use primarily at highway crossings protected by flasher lights. The relay has special back contacts for controlling lamp energy.

The lamp load at highway crossings has steadily increased during the last few years until regular or heavy-duty contacts can not handle the load without burning and blackening. Frequent relay changeout has become necessary. The new lamp control relay has special contacts so designed as to prevent burning and blackening.

Type K lamp control relays can be furnished with two regular front-back contacts and either two or four special back contacts for lamp control. The Type K Size 4 relay, Figure 1, with two conventional front-back contacts and two lamp-control back contacts, will handle most locations. With this relay the lamp load can be split, each lamp-control back contact being capable of carrying and breaking a 10 ampere load.

When the relay is deenergized, the armature extension drops away from the l-c. back contacts. Vibration from the armature is not carried to the contacts either when the armature is falling or when the relay is deenergized.

Coils in the lamp control relay are of lower resistance than those used in regular line relays. This is necessary in order to obtain fast pickup, to open the back contacts as rapidly as possible. Slow release washers on the cores let the armature down gently.

The armature in the lamp control relay is equipped with a coil spring as shown in Figure 2. The spring is a precaution against armature bounce which might result from roadside vibration. It is pointed out, however, that suitable shock mounting for the relay is still an absolute necessity. The mountings recommended are shown in the G-R-S Catalog Section E Part 21 on Page 213, Figure W and Z.

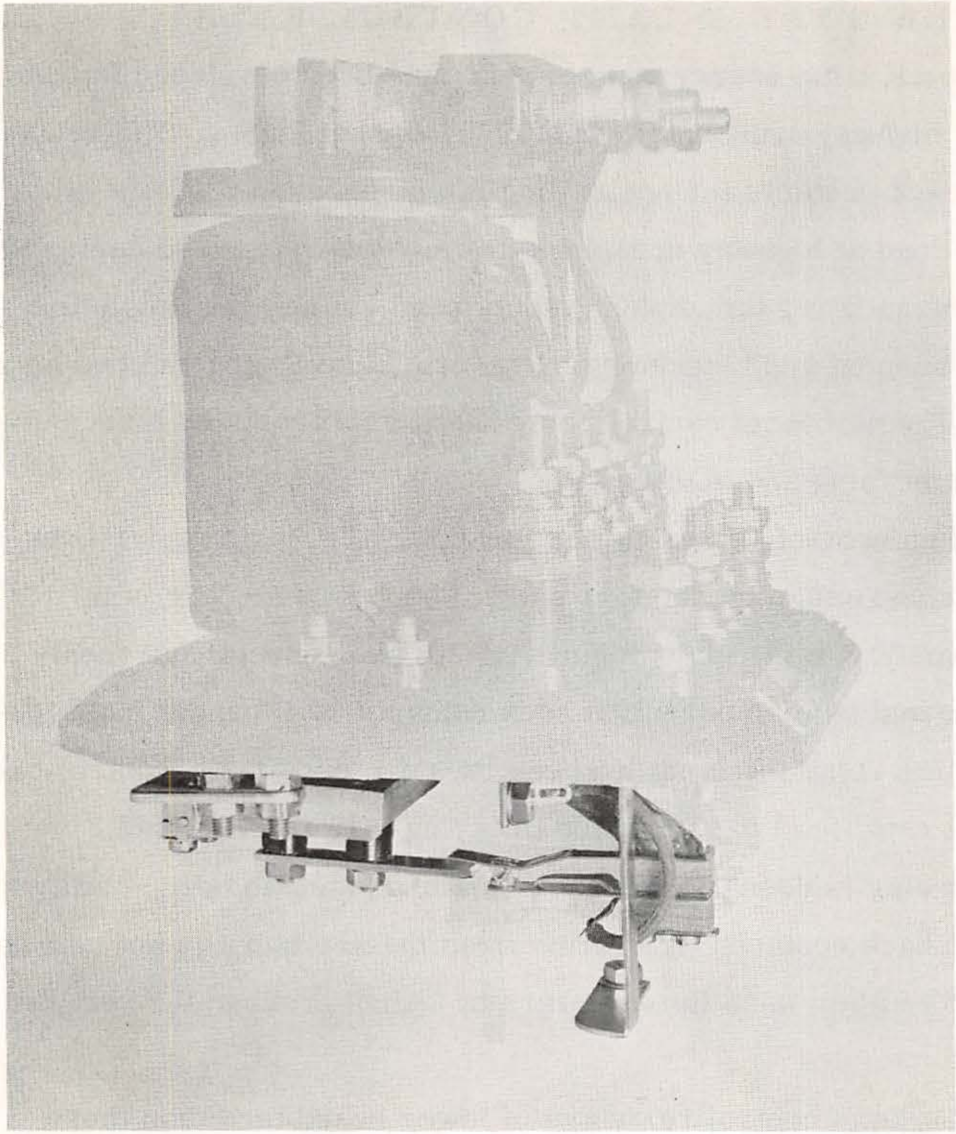


Figure 1. Type K lamp energy control relay.

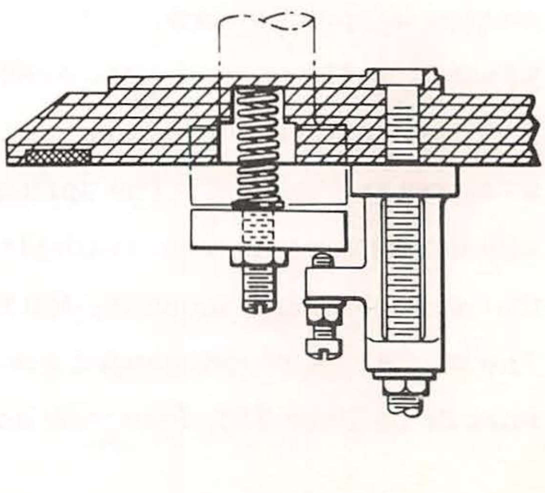


Figure 2. Coil spring in armature of Type K4 Relay.

SWITCH MACHINE CONTROL CIRCUIT

for Dynamic Snubbing of Model 5D Switch Machines

The biased-neutral controller for the Model 5D switch machine will soon be furnished with provision for dynamically snubbing the switch machine motor after it has operated and locked the switch.

Advantages

This arrangement has three advantages over the present controller:

1. Helps to maintain proper brake adjustment by reducing strain on brake parts.
2. Increases life of brake lining, as brake has less work to do.
3. Provides an additional means of stopping the motor, thus further reducing possibility of damage to machine caused by overrun and "bumping".

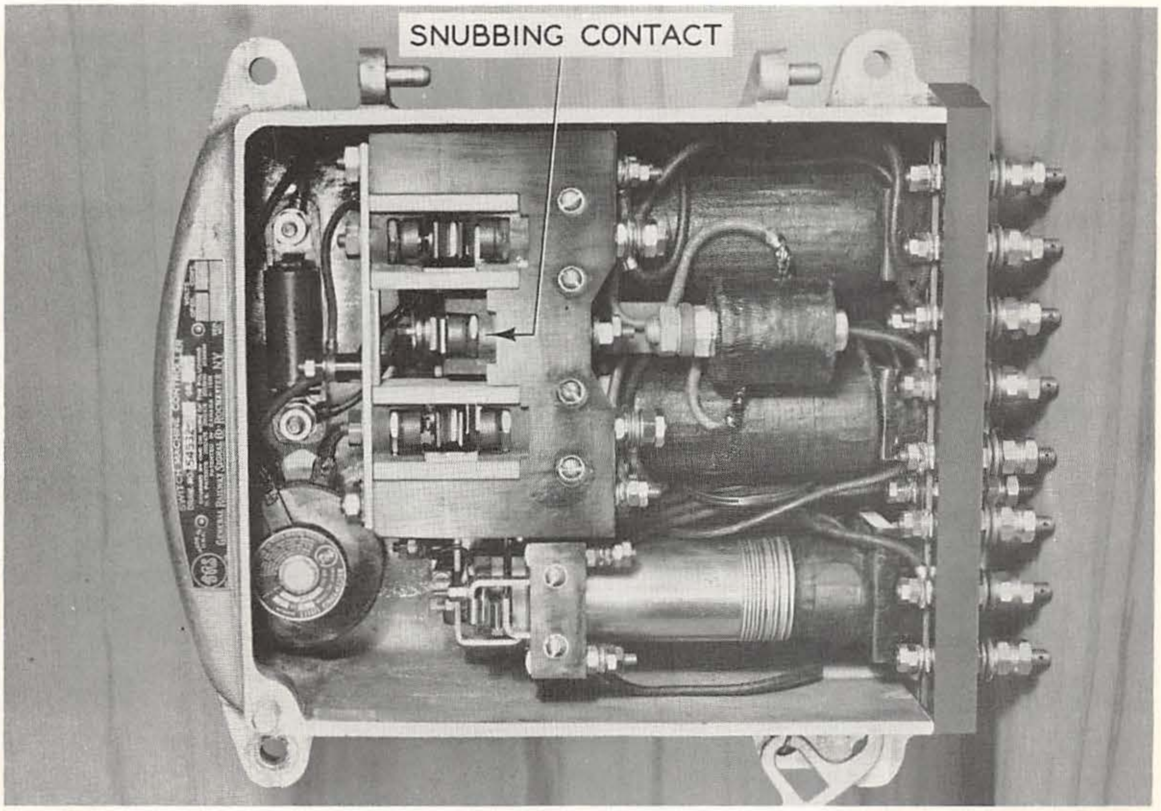


Figure 3. Top view of biased-neutral controller, showing snubbing contact, snubbing rectifier, and resistor.

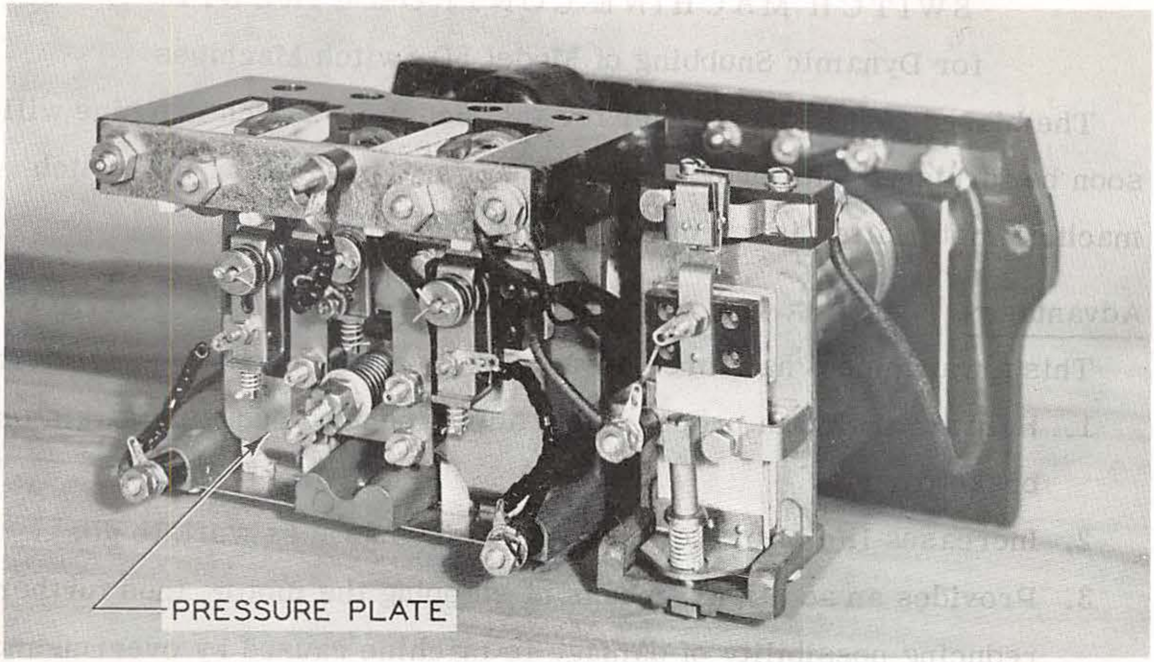


Figure 4. Controller terminal board with contactors and overload relay attached.

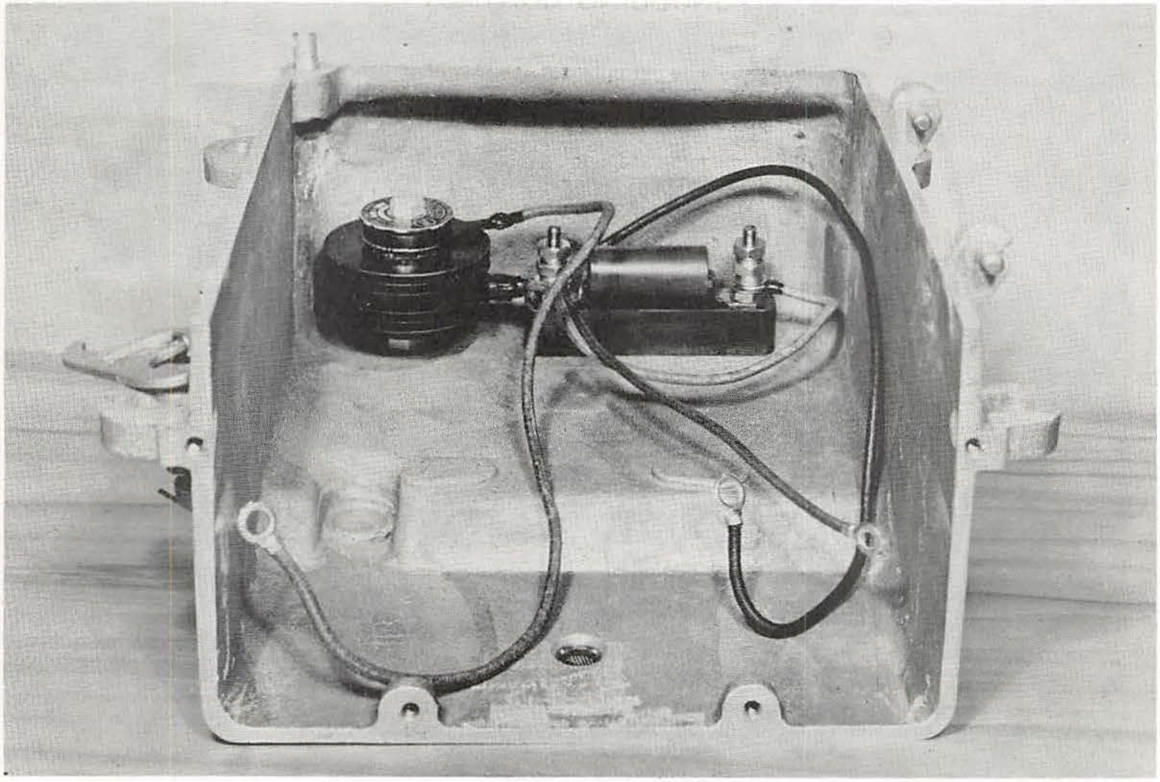


Figure 5. Controller housing, showing location of snubbing rectifier and resistor.

Laboratory tests made with a 110-volt d-c. high-speed machine, machine unloaded, gave the following results:

Stopping equipment	Crank turns left before bumping
brake only	3/4
snub only	1-1/8
brake and snub	2

Structural Changes

Figure 3 shows the controller complete with this new arrangement. It looks much like the present biased-neutral controller except for the addition of a snubbing contact operated by the contactors, a snubbing rectifier, and a resistor.

Figure 4 shows the added snubbing contact. It is located between the regular normal and reverse contactor contacts. The finger of this normally closed contact is attached directly to the pressure plate. Whenever

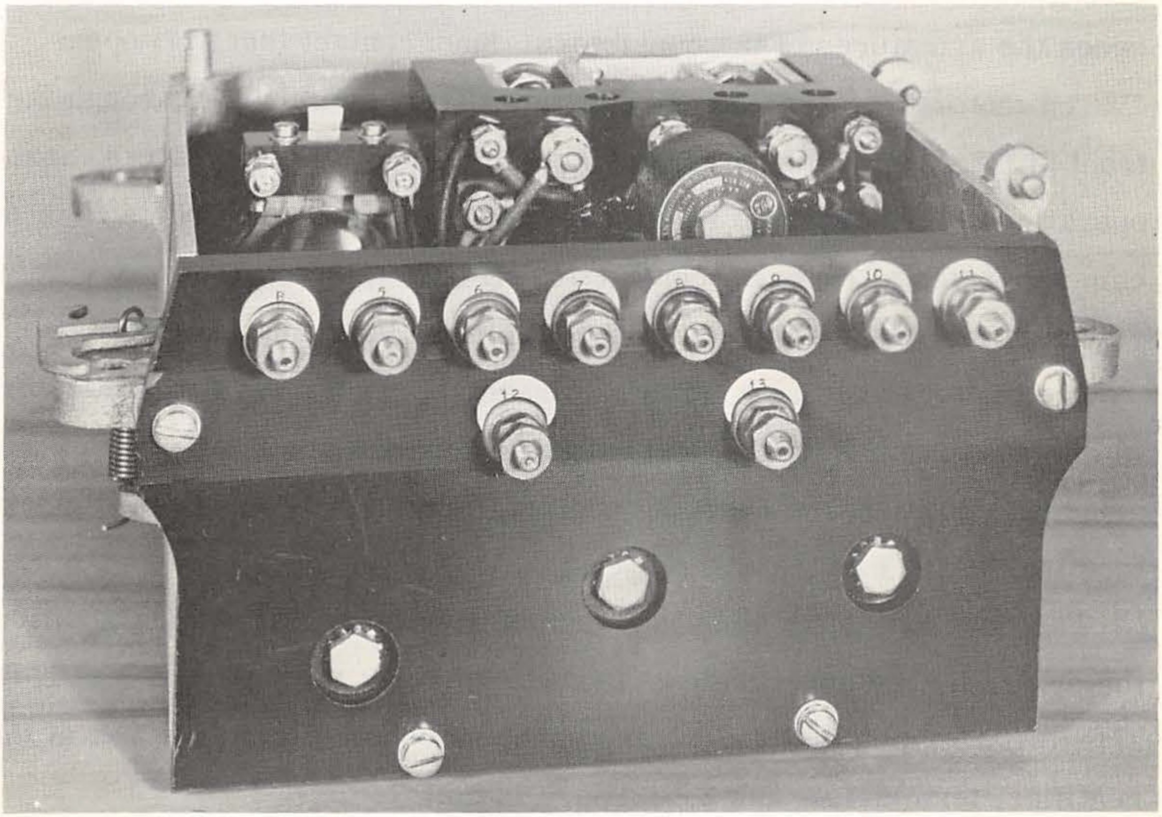


Figure 6. Controller terminal board, showing binding posts 12 and 13 as added for snub circuit.

either contactor picks up, the opposite contactor is operated by mechanical linkage to close its back contact, thus moving the pressure plate back and opening the snubbing contact.

Figure 5 shows how the rectifier is located in the controller housing. The resistor is used only with 110-volt operating energy.

Figure 6 shows the two additional binding posts required, 12 and 13. Engraved numerals, formerly located on the top edge of the terminal board, are omitted.

Operation

Figure 7 shows the circuit. Contacts are positioned as they would be with the machine locked normal.

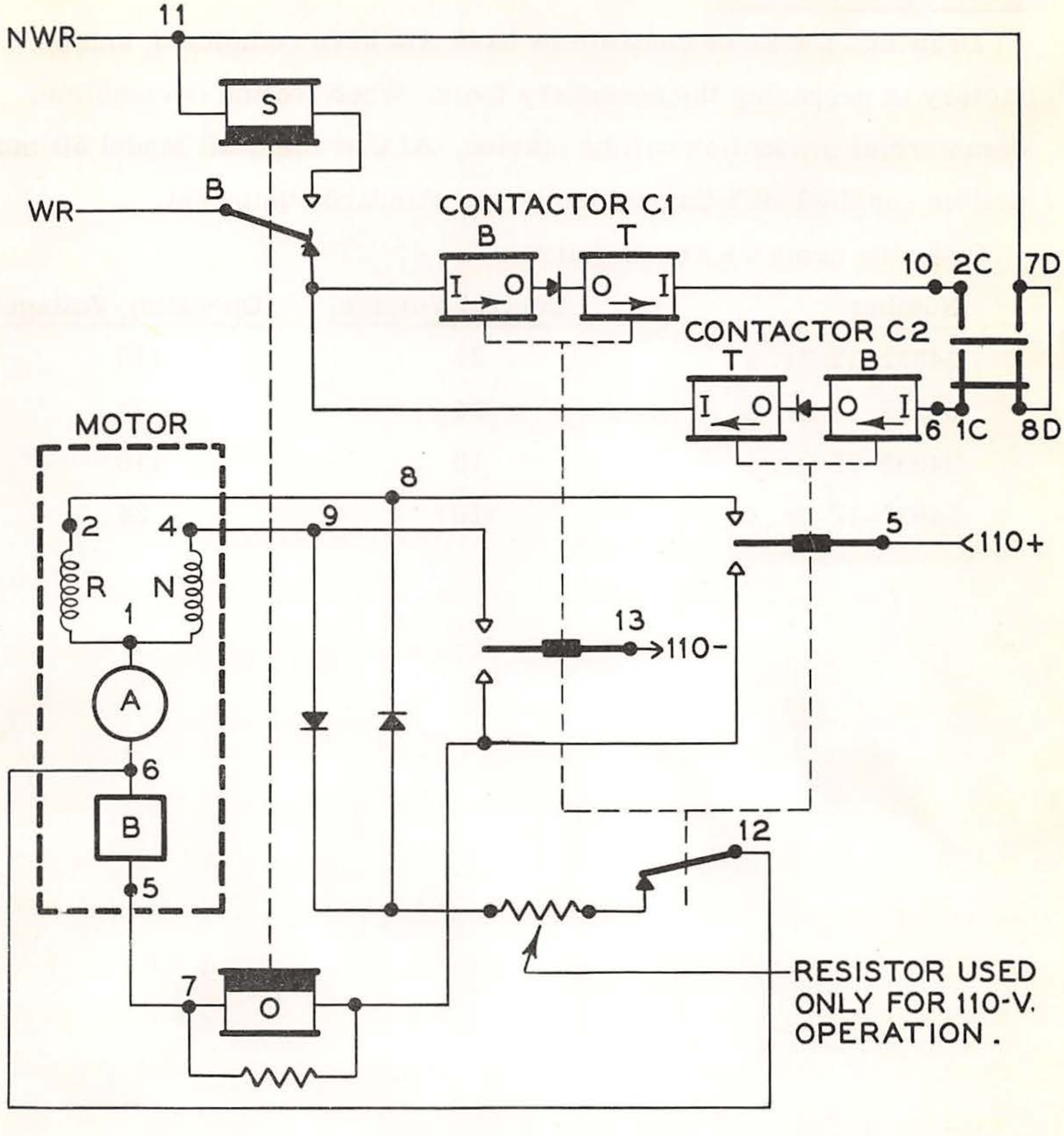
With positive on NWR and negative on WR, contactor C2 picks up, and the back contact of contactor C1 is closed by the action of the linkage between the armatures of the contactors. Snub contact (heel 12) opens.

The motor operating energy now flows from terminal 5, through the front of C2, through the reverse field of the motor, the armature, brake, operating coil of overload relay, back of C1, to negative. The switch machine operates to reverse, contact 1C-8D opens, the contactor armatures return to their normally centered position, and the snub contact closes.

The motor armature continues to revolve, generating a dynamic current which flows from field coil N through terminals 4 and 9, one half of the snubbing rectifier, the snubbing contact, terminals 12 and 6, the armature, terminal 1, and back to coil N.

When the switch machine is operated back to its full normal position, the dynamic snub current flows from field coil R through terminal 1, the armature, terminals 6 and 12, the snubbing contact, the other half of the rectifier, terminals 8 and 2, and back to coil R.

This snub is just as effective if the contactors are deenergized in mid-stroke, regardless of the direction in which the machine is operating.


NWR
11
S
WR
B
CONTACTOR C1
B
T
I
O
O
I
10
2C
7D
CONTACTOR C2
T
B
I
O
O
I
6
1C
8D
MOTOR
8
2
4
9
5
110+
R
N
1
13
110-
A
6
B
5
12
7
O

RESISTOR USED ONLY FOR 110-V. OPERATION.

Figure 7. Switch machine controller circuit with snubbing arrangement.

Symbols:

Motor: R - reverse field. N - normal field.
A - armature. B - brake.

Overload relay:
S - stick coil. O - operating coil.

Contactors:
B - bottom coil. T - top coil. I - "in" lead.
O - "out" lead.

Ordering Information

Drawings for these controllers have now been completed, and the factory is preparing the necessary tools. When tooling is complete, commercial production will be started. At that time, all Model 5D machines will be supplied with this controller as standard equipment.

Ordering numbers are as follows:

Number	Control Voltage	Operating Voltage
54532-12 Gr. 1	24	110
54532-12 Gr. 2	24	24
54532-12 Gr. 3	10	110
54532-12 Gr. 4	10	24

STANDARD SYNCROSTEP SYSTEMS

Syncrostep systems have been standardized, with the following type designations:

Type A3, Size 7.9, Class S, simplex
Type A4, Size 11.9, Class S, duplex

The size of the system refers respectively to the number of steps in a cycle (7 or 11) and the rate at which the steps are taken per second (9). Class S means the system is for a single location.

In simplex operation, one relay system handles both controls and indications so that only one transmission can take place at a time, controls having superiority over indications. In duplex operation, controls and indications can be transmitted independently of each other and at the same time. Separate relay systems are used so that their operations do not interfere with each other.

* * *

GENERAL RAILWAY SIGNAL COMPANY

G-R-S NEWS

November 1951

In this issue:

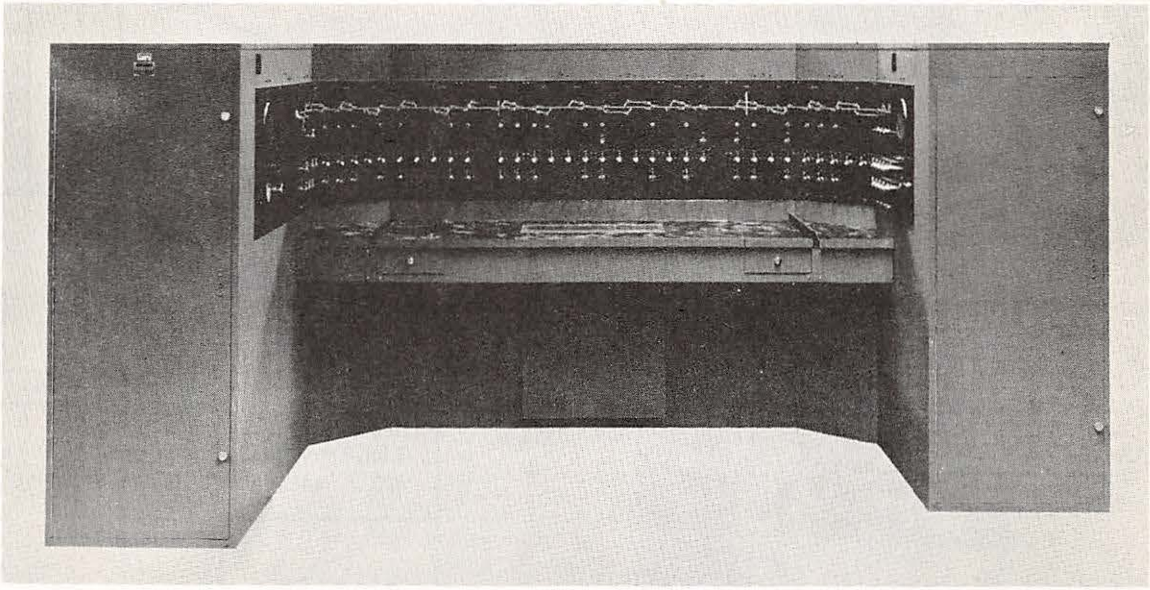
- New cTc control machine
- Relief gap plates for Type K relays

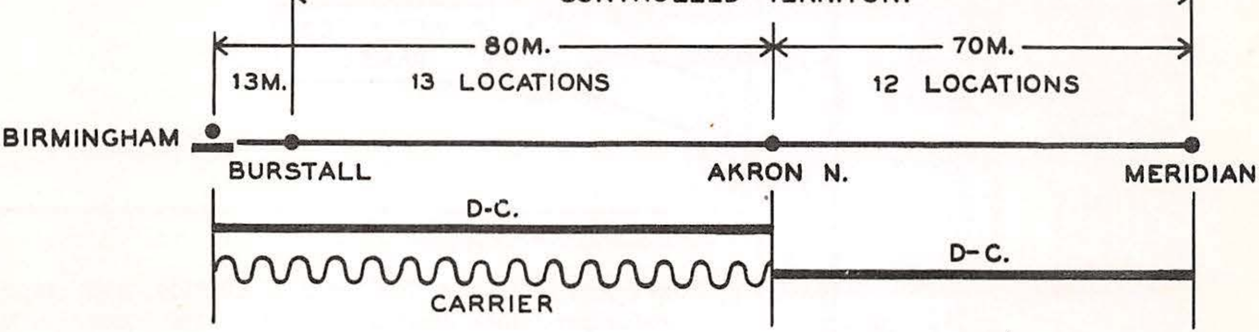
NEW CTC CONTROL MACHINE

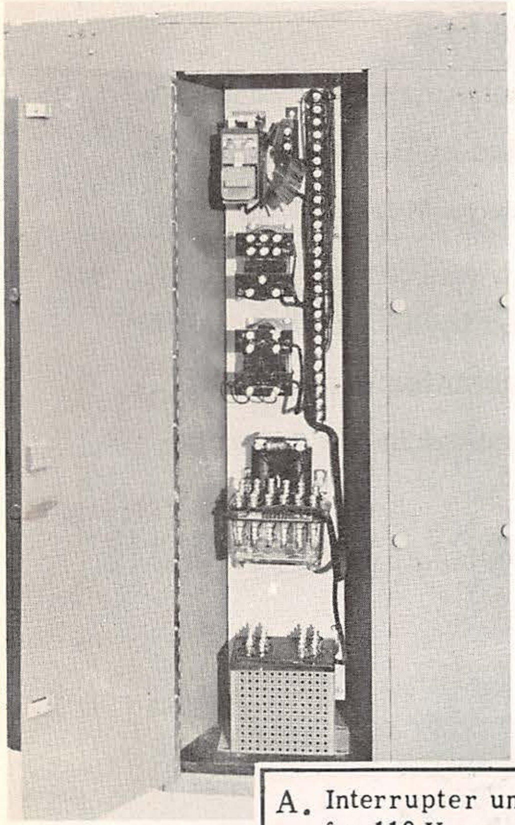
A cTc control machine with some unusual features has been supplied to the Alabama Great Southern. It is being installed at Birmingham, Ala. to control a 137-mile territory from Burstall, Ala. to Meridian, Miss. Burstall is 13 miles south of Birmingham.

Approximately half of the territory is controlled by d-c. codes and the remainder by carrier, using 12 kc. for control transmission, and 18 kc. for indications. All office carrier equipment is housed in the control machine.

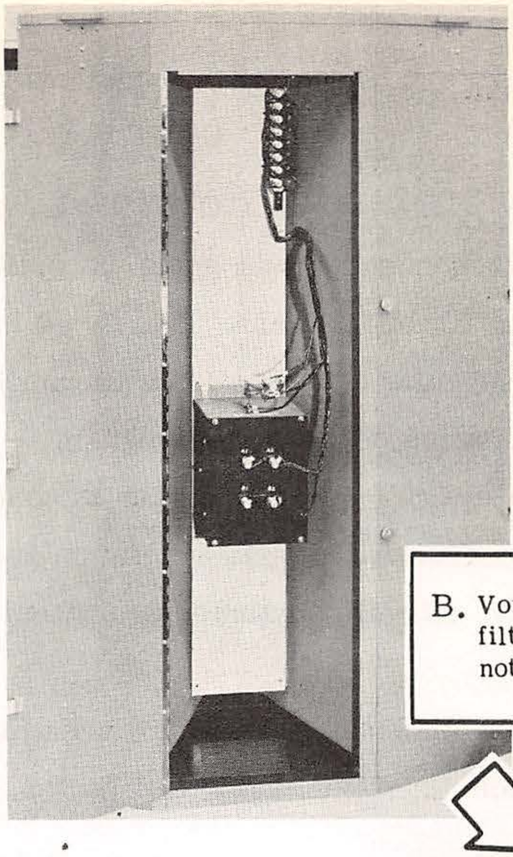
The cTc line is used by railroad forces for telephone, using portable phones (Western Railroad Supply Co. Unifone).



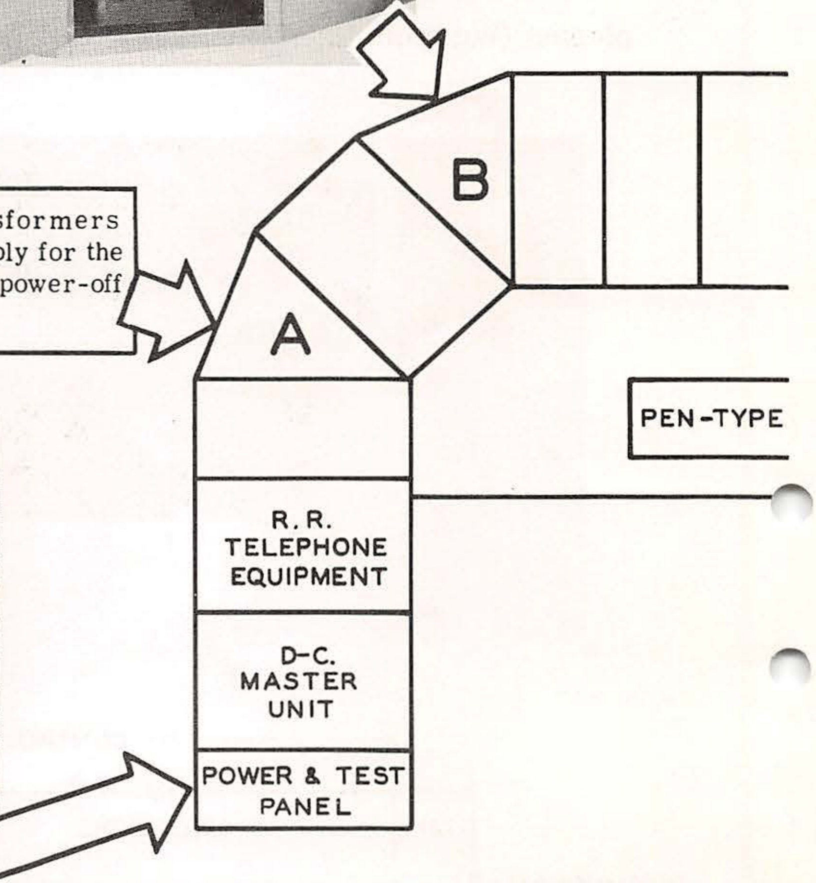

CONTROLLED TERRITORY
80M.
70M.
13M.
13 LOCATIONS
12 LOCATIONS
BIRMINGHAM
BURSTALL
AKRON N.
MERIDIAN
D-C.
D-C.
CARRIER

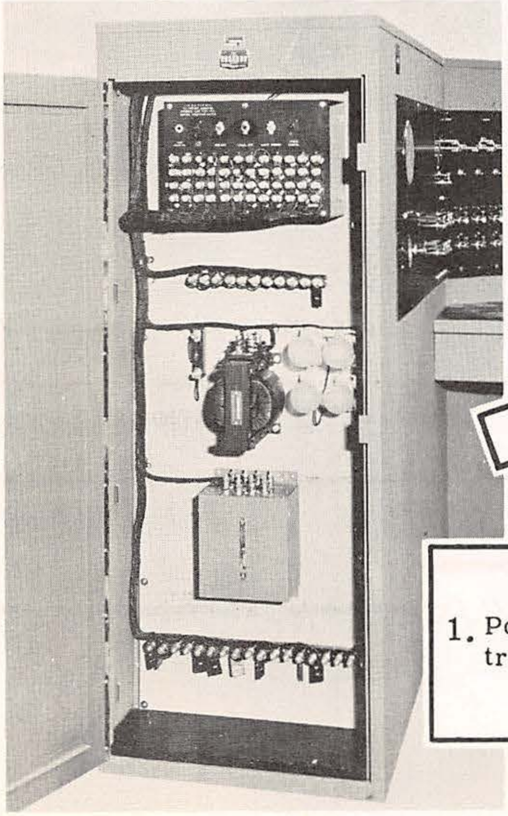


A. Interrupter unit and transformers for 110 V. a-c. standby supply for the recorder; transformer and power-off relay for panel lights.

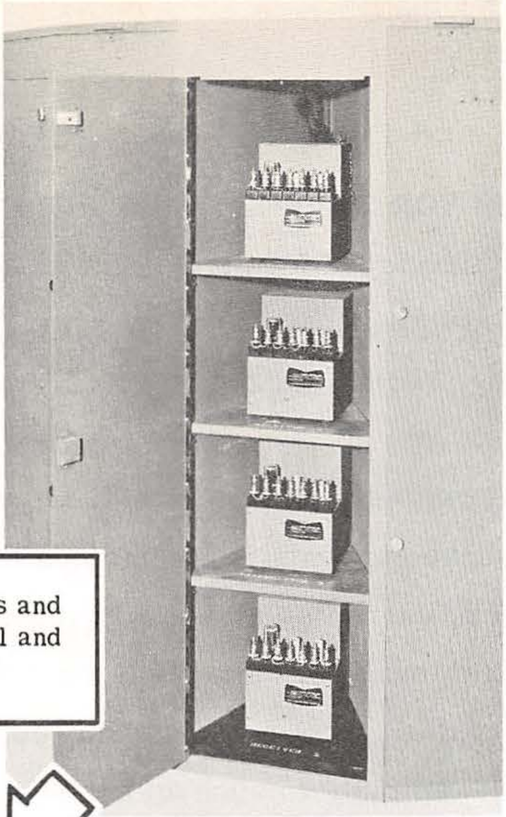


B. Voice-pass and code-pass filter section. C-p. filter not shown.

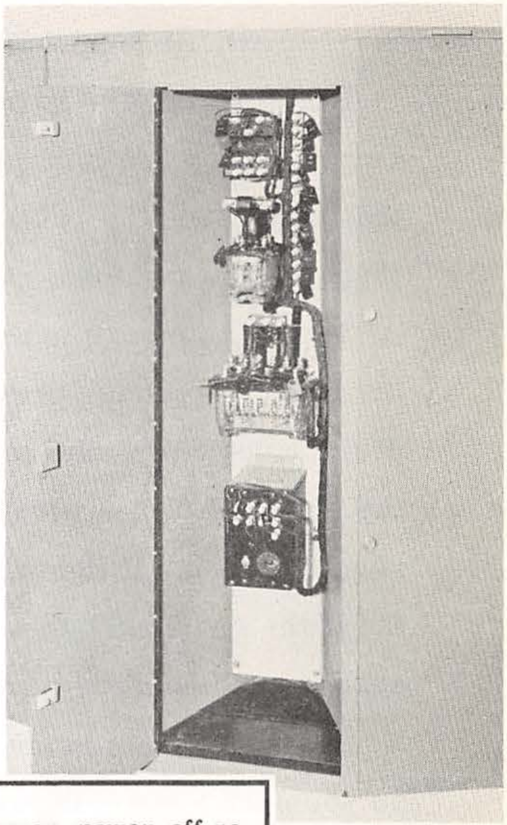

B
A
PEN-TYPE
R.R. TELEPHONE EQUIPMENT
D-C. MASTER UNIT
POWER & TEST PANEL



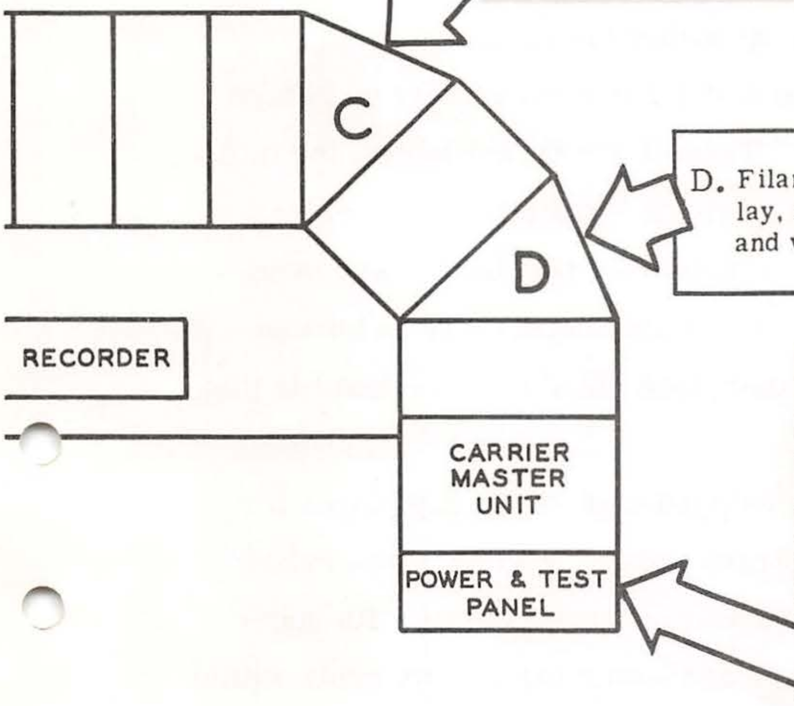
1. Power and test panel for the d-c. section, with impulse transformer, line-limiting resistance, and condenser unit.

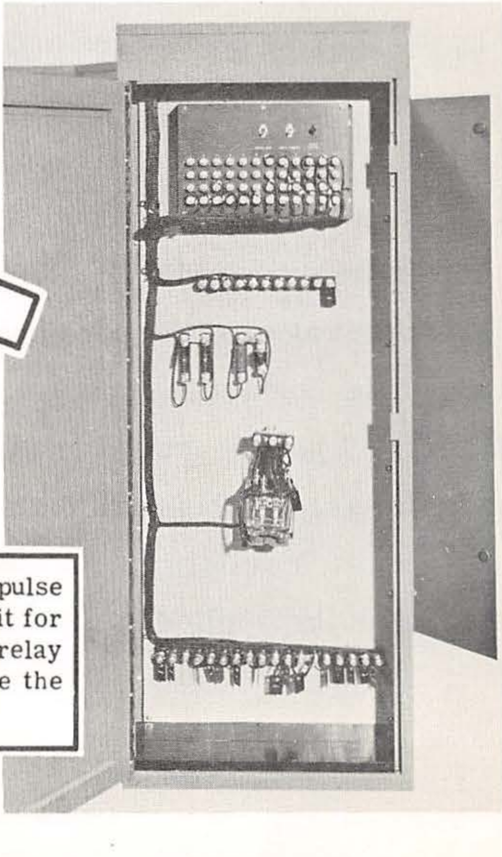


C. Carrier transmitters and receivers for normal and standby use.



D. Filament transformer, power-off relay, transfer relay for carrier units, and voice-actuated calling unit.





2. Power and test panel for the carrier section. The impulse transformer, limiting resistances, and condenser unit for this section are in a bungalow at Akron North. The relay is controlled by the voice-actuated unit to operate the code-line telephone indicator and buzzer.

RELIEF GAP PLATES FOR TYPE K TRACK RELAYS

Relief gap plates have been developed for application to Type K track relays. They are metal plates so positioned as to by-pass surge currents that may reach the relay. They prevent these currents from passing through the armature.

These plates are not considered as lightning arresters. Even though the relief gap plates prevent surge currents from entering the armature of the relay, the passage of these currents damages other parts such as the coils. It is conceivable that a surge of very great magnitude could reach the relay if lightning arresters were not used and could overload the paths provided by the relief gap plate to such an extent as to cause secondary discharge paths to be set up within the relay.

Results of tests made at G-R-S and at Purdue University on relays so equipped are highly satisfactory. These tests do not justify the omission of good lightning protection and periodic inspection of arresters and relief gap plates, if the inspection discloses that there have been lightning discharges. A relief gap plate could conceivably be burned away by successive discharges and therefore should be checked for this condition and renewed if necessary.

Type K2 track relays have been equipped with relief gap plates for several years. On Type K4 neutral track relays, Figure 1, the relief gap plate snaps over a ridge on the armature support plate. Its upper extensions rest against the core heads and lower extensions come within 1/8-inch of the contact fingers.

Plates for Type K6 neutral and polar and Type K8 polar and retained-neutral polar track relays are the same. Two kinds of plates are used on these relays, a relief gap plate and a connector plate. Figure 2 shows how the plates are applied to a K6 relay.

K6 and K8 relays require a relief gap plate for each armature finger which projects within 1/8-inch of the armature support bracket. Two connector plates are also required for these relays, one for each armature support stud to connect the armature support bracket to the cores.

Type K interlocking relays have plates similar to those described above. These plates are furnished only when the relay has a track winding.

All Type K track relays manufactured since October 18, 1951 have been equipped with relief gap plates. All relays which have been in stock will be shipped without relief gap plates until February 1, 1952. Any stock relays left over after this date will be equipped with plates.

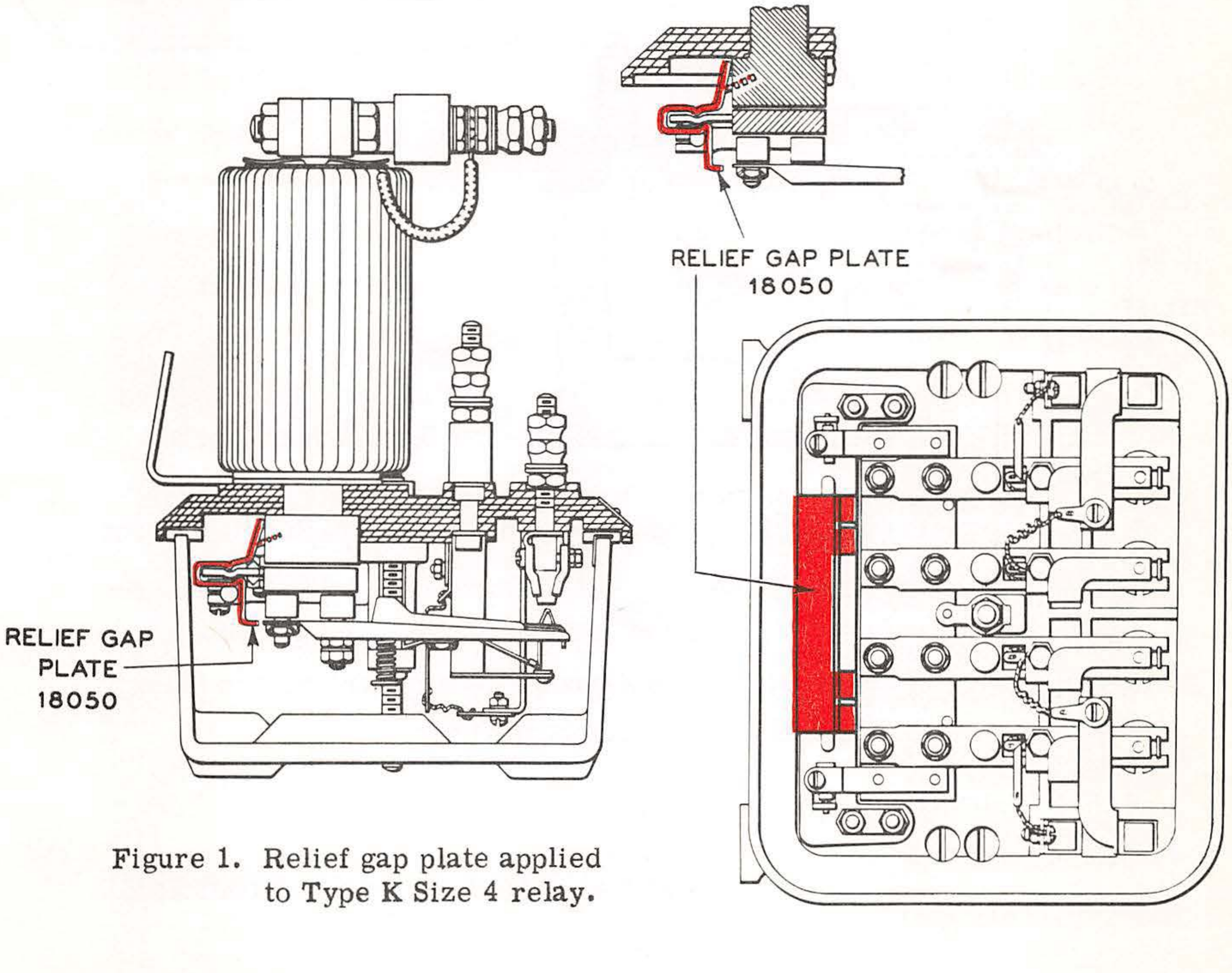


Figure 1. Relief gap plate applied to Type K Size 4 relay.

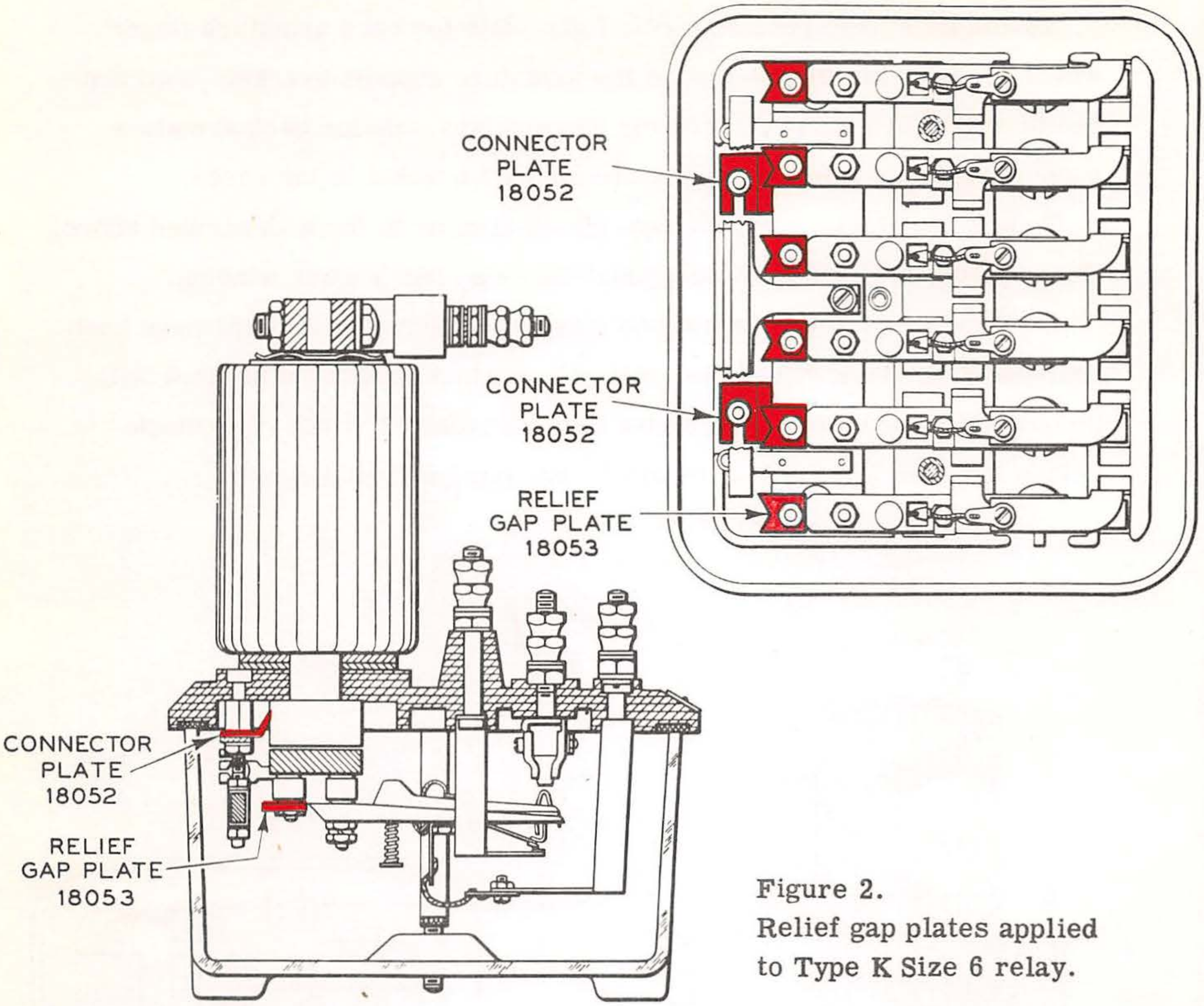

CONNECTOR PLATE 18052
CONNECTOR PLATE 18052
RELIEF GAP PLATE 18053
CONNECTOR PLATE 18052
RELIEF GAP PLATE 18053

Figure 2.
Relief gap plates applied to Type K Size 6 relay.

All these plates can be installed on existing Type K track relays. The presence of insulated stops does not interfere with their application. An instruction folder for the application of these plates is being written.

The catalog is being revised and a change notification sheet is being prepared. These publications will soon be available.

G-R-S NEWS

October 1951

In this issue:

Type VX relay

Type A biased-neutral relay

Unified (UN) thread system adopted

Plastics as used in signaling

NX interlocking at Fostoria
returns 42% on investment

TYPE VX RELAY

The Type VX polar-biased relay, Figure 1, is a fast-acting, double-winding line relay with a maximum of four dependent normal-reverse contacts. One winding is steadily energized to provide an electrical bias which tends to turn the rotary armature in a direction to close the reverse contacts. The other winding is connected to the line and, when energized with the proper polarity, causes the armature to turn clockwise to close the normal contacts. The value of line current required to close the normal contacts is dependent on the amount of biasing current. With bias

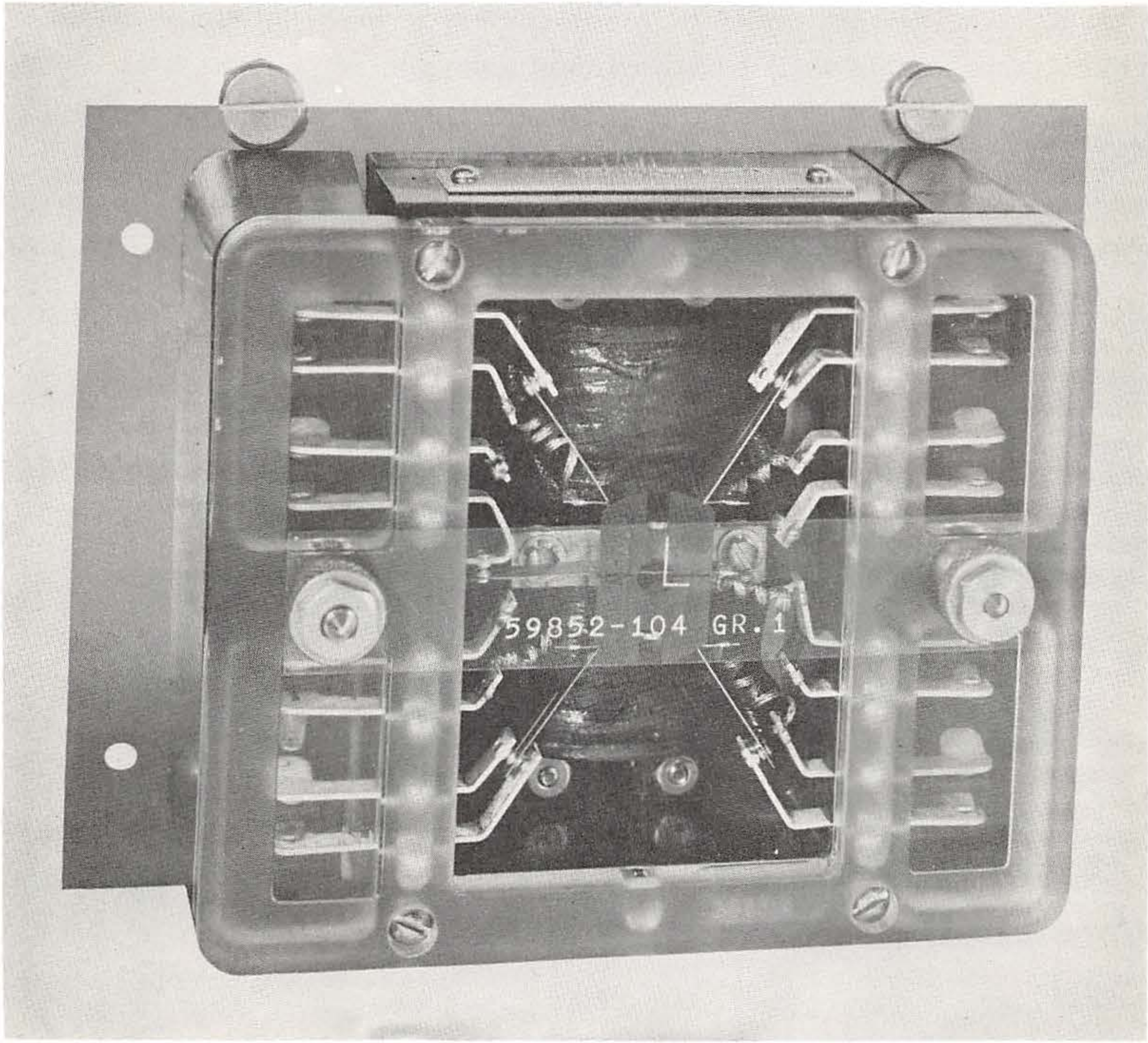


Figure 1. Type VX polar line relay on its plugboard.

current adjusted, for example to 106 milliamperes, the line current to operate the relay is approximately 60 milliamperes.

Application

The relay is particularily adapted to long line circuits with many stations along the line. You can adjust the VX relay at each station to operate with the line voltage available at that particular station. Difficulties caused by drop in line voltage are overcome by the bias adjustment.

The design of this relay is such that the magnetic force is transferred directly into contact pressure, independent of bearing friction. As a result, the VX relay has extremely fast, positive operation and long life without appreciable wear or adjustment changes.

Mountings

The VX plug-in relay occupies the space of 3 Type A relay plugboards. It is 6 inches wide, 4-1/2 inches high and 3 inches deep. The relay mounting, Figure 2, consists of two molded plugboards which are attached to a

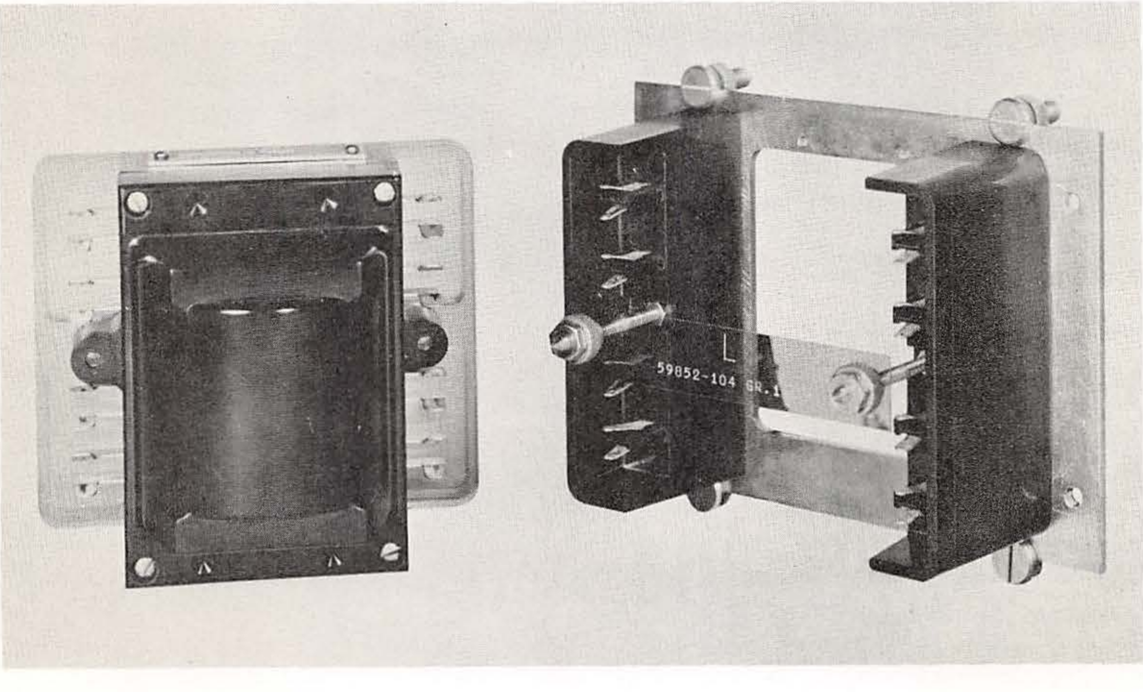


Figure 2. Type VX polar line relay unplugged.

plate. The plugboards have detachable solder terminals, similar to those used on B relay plugboards, for external wiring connections.

The mounting can be installed in a Type A relay cabinet, Figure 3, or bolted to a combination shelf and wall mounting as shown in Figure 4. Assemblies of plates and plugboards are also available for installing VX relays in Type B relay racks.

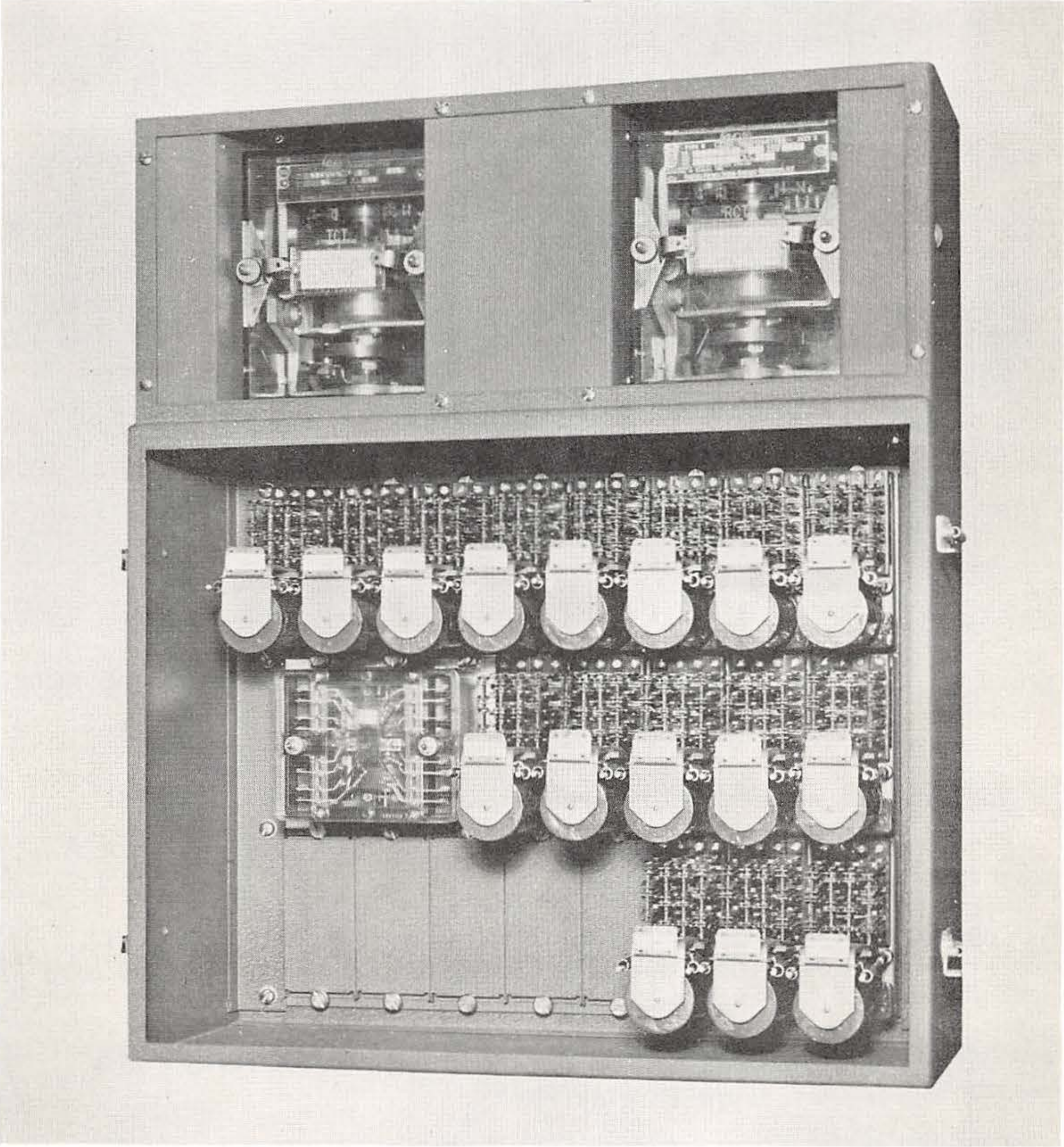


Figure 3. Type VX relay installed in a Type A relay cabinet.

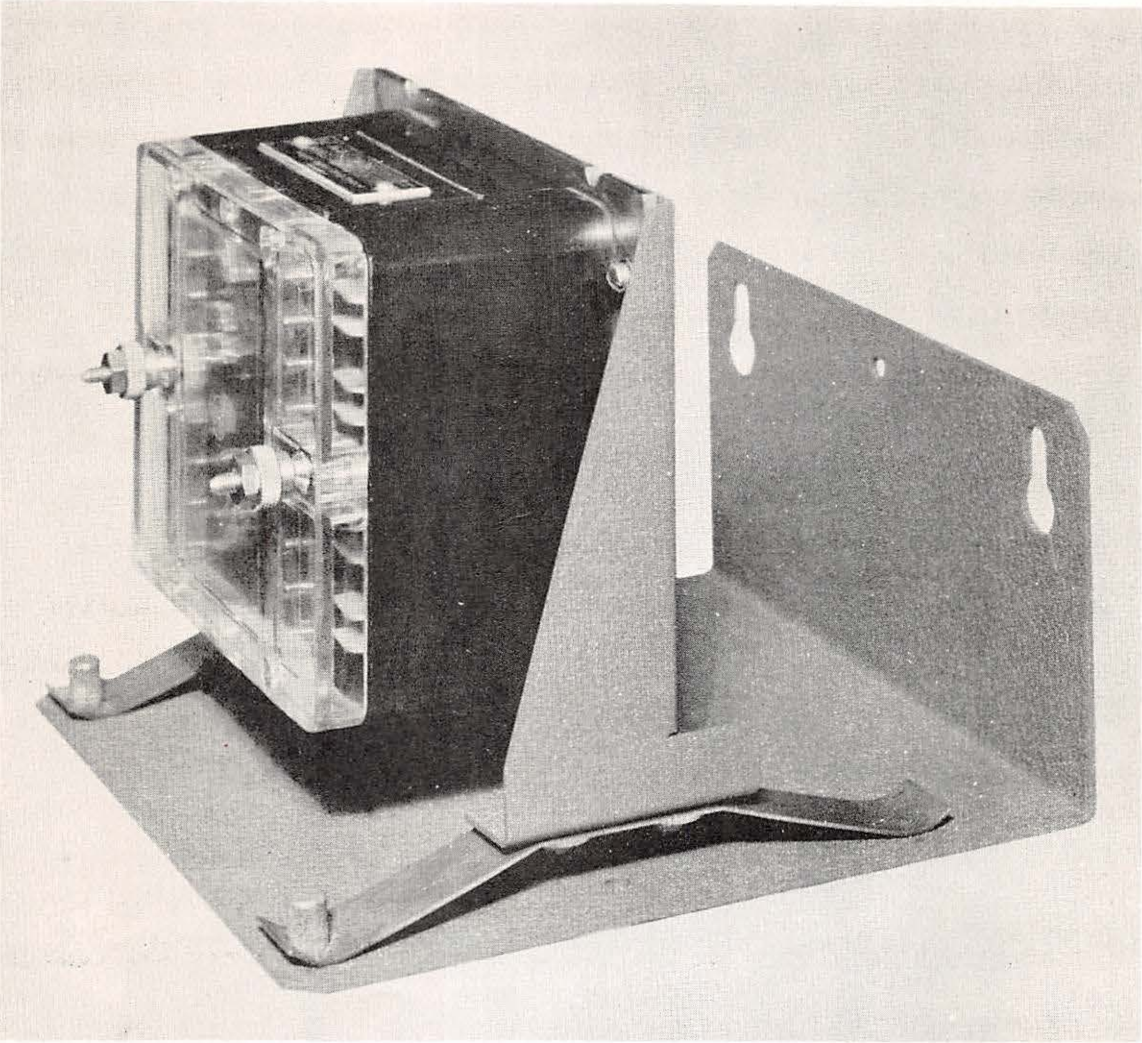


Figure 4. Type VX relay bolted to combination shelf and wall mounting.

The mountings listed below are available for Type VX relays:

30268-3 Gr. 1	assembly is for mounting the relay in a Type A relay cabinet.
30268-7 Gr. 1	assembly is a shelf or wall mounted bracket. 30268-3 Gr. 1 assembly above is necessary to adapt the relay to this mounting.
30268-8 Gr. 1	assembly is for mounting two VX relays on a Type B relay rack.
30268-8 Gr. 1	assembly is for mounting one VX relay on a Type B relay rack.

TYPE A BIASED-NEUTRAL RELAY

The Type A biased-neutral relay, Figure 5, is now being used in NX circuits, initiation networks. For end-to-end operation, it is a means of coupling between adjacent groups in the same direction of traffic.

The relay will pick up with positive energy applied and remain down when negative energy of the same value is present. It operates on 12 volts direct current.

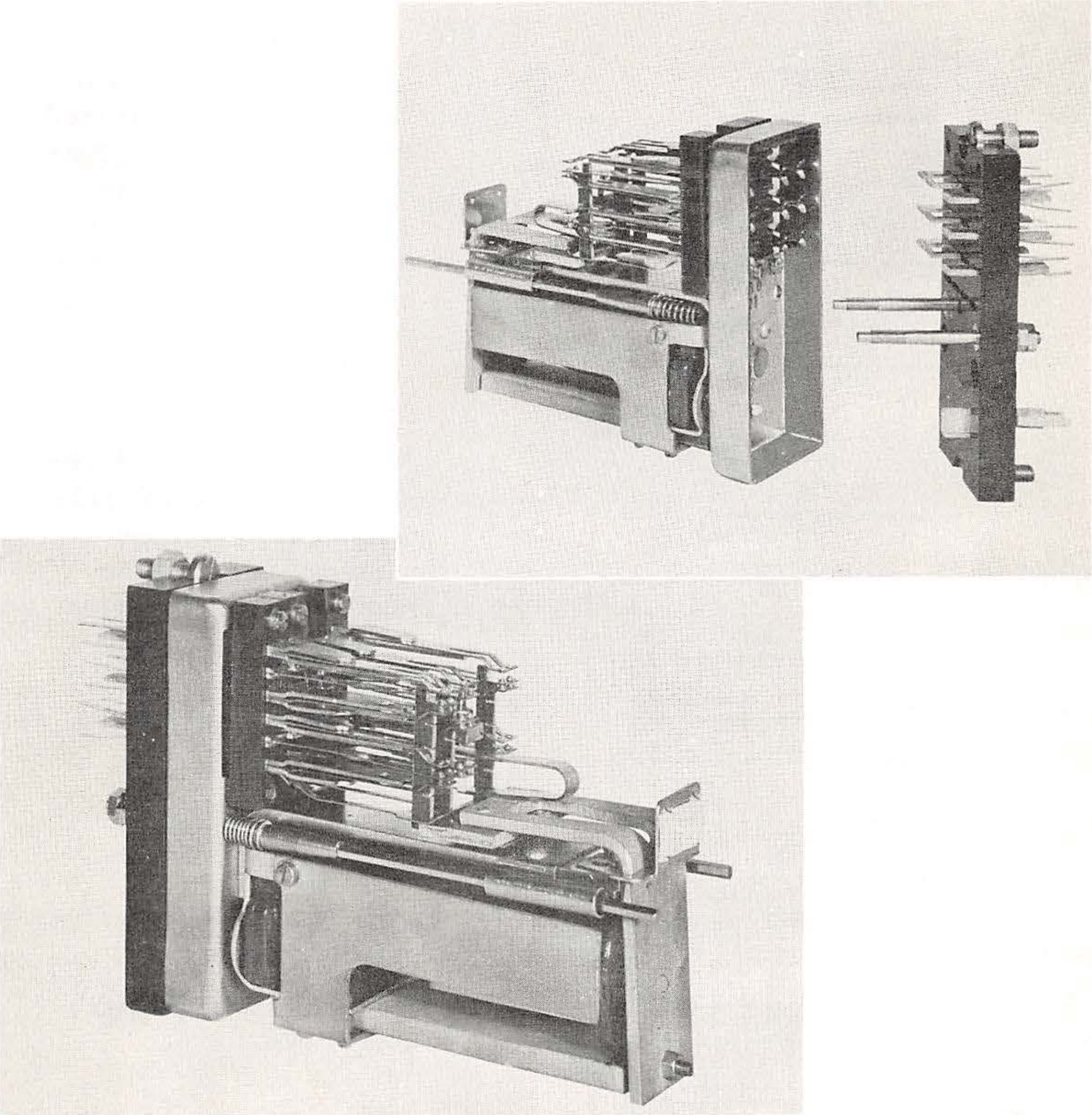


Figure 5. Type A biased-neutral relay.

How it Works

The diagrams show the magnetic structure of the relay and how it works. With the polarity of the permanent magnet as shown in Figure 6, and no current flowing through the coils, the major portion of the magnet's flux finds a parellel path of low reluctance through the leakage strip. Some flux passes through the core, but the magnetic force is so small it fails to pull the armature up to the pole face against the pressure of the hold-down spring.

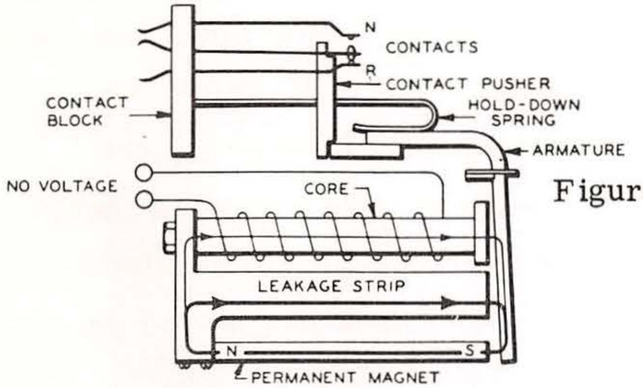

N
CONTACTS
R
CONTACT PUSHER
CONTACT BLOCK
HOLD-DOWN SPRING
ARMATURE
NO VOLTAGE
CORE
LEAKAGE STRIP
N
S
PERMANENT MAGNET

Figure 6.

Type A biased-neutral relay in the unenergized position, with the armature held down by the spring. Most of the magnet flux is in the permanent magnet and leakage strip.

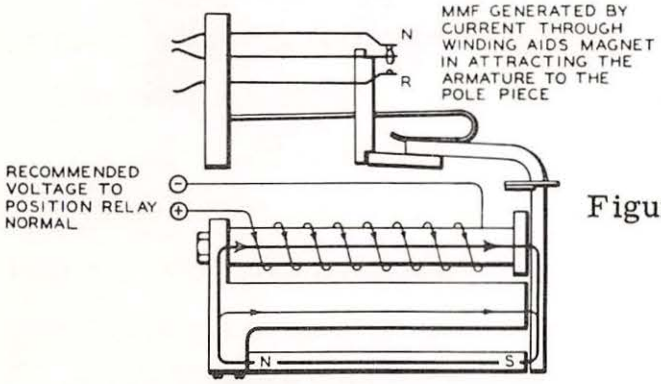

N
R
MMF GENERATED BY CURRENT THROUGH WINDING AIDS MAGNET IN ATTRACTING THE ARMATURE TO THE POLE PIECE
RECOMMENDED VOLTAGE TO POSITION RELAY NORMAL
⊖
⊕
N
S

Figure 7.

Armature of Type A relay picked up with positive polarity across winding. Most of the magnet flux is diverted through the armature because of the lowered reluctance through the core.

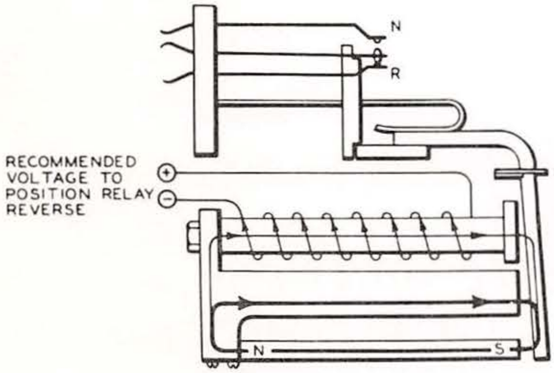

N
R
RECOMMENDED VOLTAGE TO POSITION RELAY REVERSE
⊕
⊖
N
S

Figure 8.

Armature of Type A relay knocked down with negative polarity across windings.

Let us now apply a positive voltage to the coil which will tend to lower the reluctance of the core, as shown in Figure 7. The combination of permanent magnet flux and coil flux through the leakage strip tends to saturate the leakage strip and cause even more of the permanent magnet flux to seek a path through the armature of the relay. The armature picks up.

The armature will remain up as long as the coils are energized. When you open the circuit, you destroy the magnetomotive force opposing the permanent magnet. The flux of the permanent magnet once more resumes the low reluctance path through the leakage strip, a path which has lower reluctance than the one through the armature and core. Since there is no force to hold the armature up, it falls away from the pole piece.

Let us assume you apply a negative voltage to the coils. As shown in Figure 8, this would merely create a magnetomotive force which would aid the magnetomotive force of the permanent magnet and the flux would remain in the leakage strip.

You have probably been wondering why the heavy flux from the magnet, through the armature, and through the leakage strips does not pick up the armature. You'll find the answer in Figure 9. Note how the strips are set off to the sides of the armature (you are looking down on the relay). Any pulling effect is therefore sideways. The strips cannot exert a direct pull on the armature. Moreover, because the gap between the magnet and the armature is so great, the pull there is too small to be of any use.

NX Circuit Application

Type A biased-neutral relays were developed for use in NX initiation networks. Their application is as follows.

When you push the entrance knob on the NX control machine, positive energy is applied to the initiation network which picks up the biased-

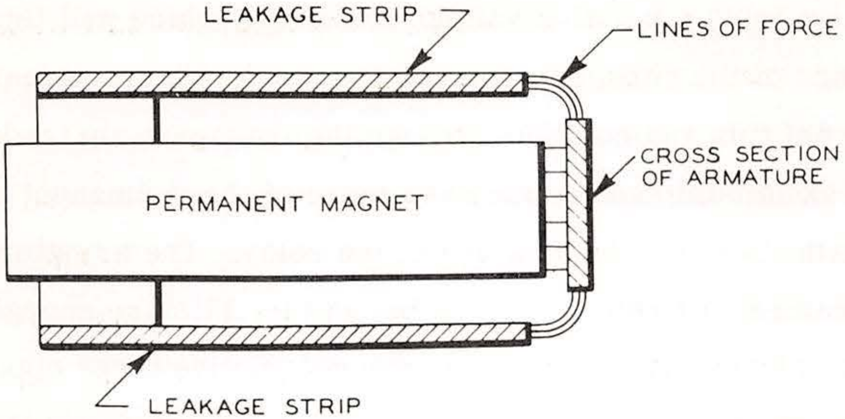


Figure 9. Top view showing how the magnet, strips and armature are related. The tendency for the flux is to crowd on the edges of the armature where the pulling effect is practically nil.

neutral relay and couples the network groups together. When you push the exit button in the route, all intervening signals are cleared, resulting in end-to-end operation.

When you TURN the entrance knob, negative energy is applied to the initiation network which cannot pick up the relay. The initial group is not coupled to succeeding groups. You can only set up the route as far as the next signal in the same direction, necessitating lever and button operation for each group to line up a complete route.

Construction

The Type A biased-neutral relay is practically the same construction as the Type A magnetic stick relay. It has, in addition to the magnetic structure of the magnetic stick relay, a fixed residual pin on the armature opposite the core, as well as the adjustable residual pin opposite the permanent magnet. A 1/2-inch slug is assembled on the core to make the relay slow release. This is necessary to cover the crossover time of other relays in the NX system.

The Type A biased-neutral relay is furnished with 2 front and back, 3 front, and 3 back contacts. It has one coil resistance, 130 ohms. Its working current and pick up value is 0.055 ampere.

UNIFIED (UN) THREAD SYSTEM ADOPTED

G-R-S will adopt gradually as its future standard, for screws and nuts 1/4-inch in diameter and larger, the unified (UN) thread system as covered by the American Standards Association publication ASA B1.1-1949, Second Edition. This sytem has been approved by the A.A.R., Signal Section and can be found in their manuals, Part 17, approved in March 1951.

Our previous thread system was the National Standard and will be retained for screws, nuts, and other threaded parts smaller than 1/4-inch. This system will also remain in force concerning 1/2"-13 threaded parts.

The reasons for the change in thread systems is twofold. The NS thread cutting tools did not provide clearance for plating on external threads and did not cut round roots to prevent fracture. It was also advisable to follow the up-to-date trend in using the latest thread standard.

Comparison

The form of thread, Figure 10, is identical for both the unified and the former National Standard.

There are two classes of fit for unified threads, Class 2A for external threads and Class 2B for internal threads. These classes replace the Class 2 for National Standard and differ dimensionally to provide an allowance to guarantee a clearance between external and internal threads. This added clearance lessens the possibility of galling and seizure and provides space for plating on external threads.

Round root, as shown in Figure 10, can be cut with unified system tools, but is only mandatory on certain threads. It will be specified for Class 2A fits on external threads for certain rods used for switch connections where maximum fatigue strength is required.

The adoption of the new UN thread system will be a gradual process, until parts in stock are depleted and new thread cutting tools are available.

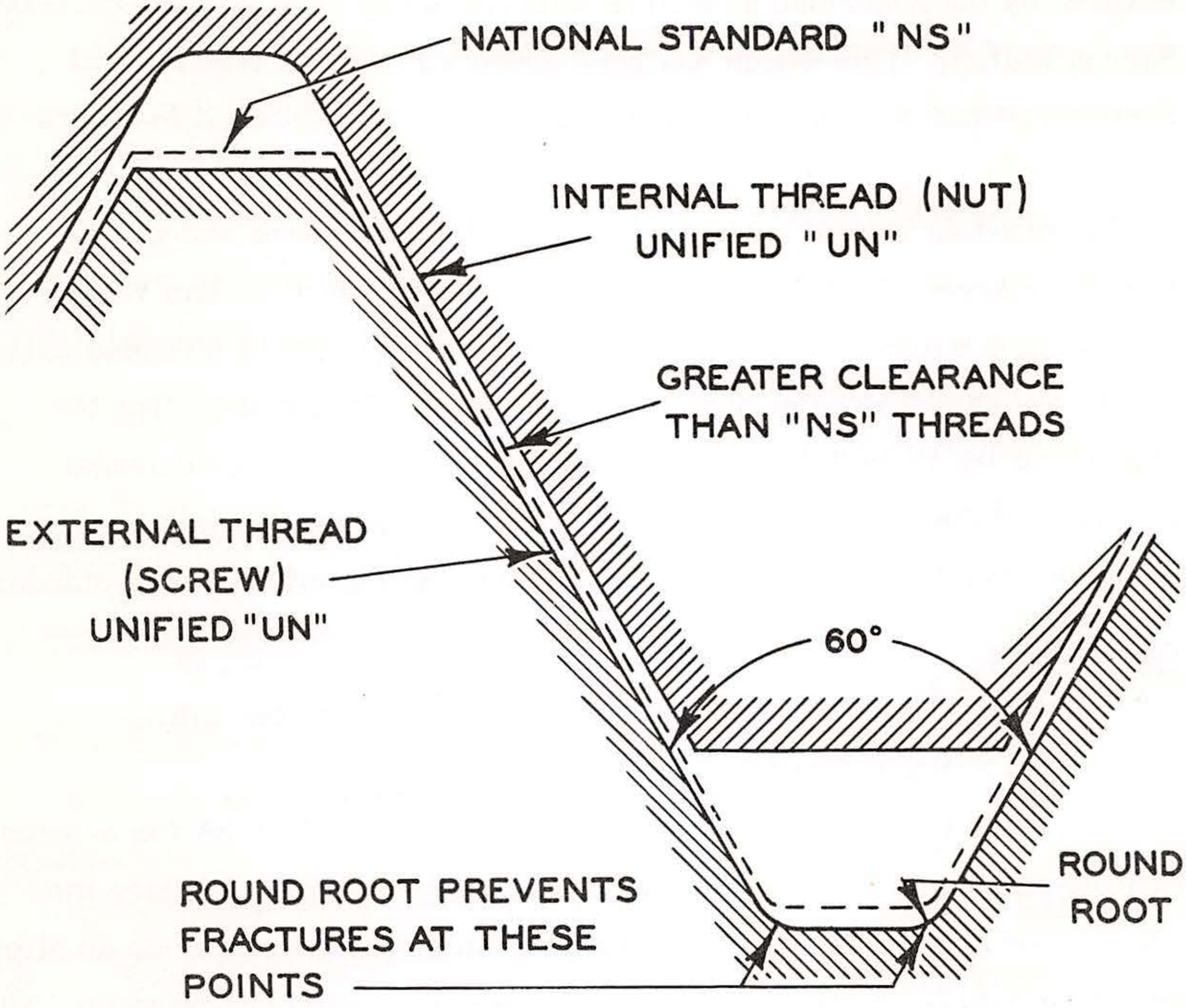

NATIONAL STANDARD "NS"
INTERNAL THREAD (NUT) UNIFIED "UN"
GREATER CLEARANCE THAN "NS" THREADS
EXTERNAL THREAD (SCREW) UNIFIED "UN"
60°
ROUND ROOT
ROUND ROOT PREVENTS FRACTURES AT THESE POINTS

Figure 10. UN threads.

PLASTICS AS USED IN SIGNALING*

Today the name "Plastic" is used generally to cover materials made synthetically, that is, not natural resins such as wood rosin, gums, tars, asphalts and waxes. Correctly defined, a plastic is any organic material, synthetic or not, that is easily cast, extruded or molded. Inorganic materials, such as the various metals and glass are not classed as plastics even though they may be cast, extruded and molded.

For many years, and even today, when plastics are mentioned one immediately thinks of Bakelite. In fact, our plastics molding department at the General Railway Signal Company plant is still called the bakelite molding department even though Bakelite is only one of the many types of plastics molded there.

Since Bakelite first came to be used, many other plastics have been developed. Each has its particular characteristics making it suitable for a special purpose. One of those characteristics is electrical insulation value and a special purpose is railway signaling.

It must be admitted that many of the chemical and technical names of plastics are difficult to understand and pronounce unless one uses them every day. That is why trade names are given to most plastics, "Bakelite" for instance. The name tells nothing of its composition. It was coined from the name of the chemist, Dr. Baekeland†, who recognized the value of the resin which an obscure German chemist obtained when phenol and formaldehyde were mixed together with other chemicals.

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*A talk by E. H. Branson, G-R-S Lab Director, before the Western Signal Engineers on July 10, 1951.

†Dr. Leo Hendrick Baekeland, Belgian-American chemist, invented the well-known Velox photographic paper, which invention he sold to the Eastman Company in 1899.

That may sound technical but phenol is only another chemical name for carbolic acid, which some people used to take when they were tired of life and taxes, and formaldehyde is that smelly stuff the undertaker uses to preserve the one who took the carbolic acid. If he uses the right proportions it might be possible for the undertaker to make a plastic corpse instead of a stiff.

There are two principal types of plastics, thermosetting and thermoplastic. The thermosetting type covers those that set-up hard when heated in a mold under pressure and will not soften if reheated. Bakelite is of this type. The thermoplastic type after molding can be softened by reheating and in many instances can be remelted and remolded. Examples of this type are Tenite, Lucite and Nylon.

Most plastics of either type are machinable, some more easily than others which require special tools and machinging technique. Special care must be taken in the machining of the thermoplastic type as the heat of machining will soften and distort the material.

Plastics are available in the same general forms as metals are available, that is, in castings or die molded forms, sheets, bars, rods, tubes and extruded shapes. In addition plastics can be extruded into filament forms comparable with silk, cotton, wool and linen yarns and threads.

In the signal apparatus industry, the two forms in which plastics are most generally used in quantity production are, first, the die molded parts such as relay top plates to which the operating mechanism and binding posts of the relay are attached and, second, plastic sheet material called "laminated phenolic plate" used for fabrication into panels, terminal boards, spacers, washers, pushers and many other parts requiring that they be made of an insulating material.

Many plastics are available today in powdered or granulated form for use in die molding. Bakelite was the first thermosetting plastic to be used widely as electrical insulation and led the field for many years as it was well covered by patents owned by Dr. Baekeland and the Bakelite Corporation. Now with the patents expired, many other resins of the same type and composition are available with trade names such as, Durez, Durite Resinox, Textolite, Micarta and Indur. Every manufacturer has a variety of grades, each of which has some particular characteristic for a particular use.

The laminated phenolic sheet material, of which large quantities are used in signaling apparatus, is standardized by the National Electrical Manufacturers Association. Various grades are available depending on the sheet material used in the laminations. Paper, fine weave cotton cloth, canvass, asbestos paper and glass fiber cloth are materials commonly used. One of the first manufacturers of this type of material, the laminated phenolic type, was the Formica Company. Their material goes by the name of Formica. Other trade names for the same product having the same characteristics are Synthane, Spauldite, Phenolite, Insurok, Textolite, Micarta, Lamacoid, Panelyte and others. These laminated materials are used in signal apparatus in the form of sheets, panels, blocks, washers, spacers, rods and tubes.

In order to illustrate the various kinds of plastics that have been developed in the United States since the year 1870 please refer to Table I (page 14) taken from the 1950 Modern Plastics Encyclopedia. An X has been placed before those plastics that have been used in the signaling industry. Many of the names given on this chart are chemical names no doubt unfamiliar to you. As we go through those marked with an X, I'll give you the common or trade names and where they are used in signaling apparatus.

Table I— Development of Plastics in the United States

1870	X	Cellulose nitrate	Sheets, rods, tubes
1895	X	Shellac composition	Molding compound
1909	X	Bitumen composition	Cold-molding compound
1910	X	Phenol-formaldehyde resin	Molding compound
1912	X	Phenol-formaldehyde resin	Laminates
1919		Casein	Sheets, rods, tubes
1919		Coumarone-indene resin	Protective coatings, adhesives
1922	X	Phenol-furfural resin	Molding and laminating compounds
1926	X	Alkyd resins	Protective coatings
1927	X	Cellulose acetate	Sheets, rods, tubes
1928	X	Phenol-formaldehyde resin	Cast sheets, rods, tubes
1928		Urea-formaldehyde resin	Cast transparent sheets
1928		Vinyl ester resins	Protective coatings
1929	X	Urea-formaldehyde resin	Molding compound
1929	X	Cellulose acetate	Molding compound
1930	X	Styrene resin	Opaque molding compound
1931		Acrylic resins	Protective coatings
1932	X	Cellulose acetate butyrate	Protective coatings
1935		Ethyl cellulose	Protective coatings
1936	X	Methyl methacrylate resin	Cast sheets
1937		Vinyl butyral resin	Binder for safety glass
1937		Methyl methacrylate resin	Molding compound
1937	X	Lignin plastic	Sheets
1937	X	Styrene resin	Transparent molding compound
1937		Cellulose acetate propionate	Protective coatings
1937	X	Nylon resin	Filaments and bristles
1938	X	Cellulose acetate butyrate	Molding compound
1939	X	Vinylidene chloride resin	Coatings and extruded tubing
1939		Methyl cellulose	Adhesives and coatings
1939		Melamine-formaldehyde resin	Molding compound
1939		Lignin plastic	Molding compound
1940		Vinyl alcohol resin	Sheets and tubes
1942	X	Nylon resin	Molding compound
1942		Allyl resin	Cast transparent sheet
1943	X	Silicone resin	Coating and laminating compounds
1943		Resorcinol-formaldehyde resin	Adhesives
1943		Vinyl carbazole resin	Molding compound
1943	X	Polyethylene	Coatings and extruded tubing
1944		Unsaturated polyester resins	Laminating compounds
1944		Hydroxyethyl cellulose	Protective coatings
1944		Chlorostyrene resin	Molding compound
1944		Furane resin	Adhesives and impregnants
1944		Carboxymethyl cellulose	Coatings and sizings
1945		Cellulose propionate	Molding compound
1946	X	Tetrafluoroethylene resin	Sheets
1947		Vinyl alkyl ethers	Coatings and sizings
1948		Unsaturated polyester (alkyd)	Molding compound
1948		Styrene-butadiene resins	Molding compound
1948		Styrene-isobutylene copolymers	Film
1948		Styrene-acrylonitrile copolymer	Molding compound
1948	X	Chlorotrifluoroethylene resin	Molding compound and film
1948		Vinyl chloride acrylonitrile copolymer	Fibers
1949		Epoxy resins	Coatings and adhesives

X Indicates plastics used in Signal Apparatus.

1870 Cellulose nitrate is celluloid once used for insulating washers, tags and wire markers. No longer used account of the fire hazard.

1895 Shellac composition formerly used in manufacture of insulating tubes with paper or mica. Very little now used except in combination with mica in commutator insulation.

1909 Bitumen composition, made of tars and asphalts mixed with asbestos, talc, etc., to mold insulating blocks, wiring devices, plugs and sockets. Not now used except for low priced wiring devices.

1910 Phenol-formaldehyde, called "Bakelite", was the first molding
1912 resin of the thermosetting type and is still being used today in large quantity production. In the signal industry this type of plastic is used for many die molded parts, laminated phenolic plate, rods and tubes for insulation panels, blocks, terminal boards, etc. It is the general purpose plastic used throughout the electrical industry.

1922 Phenol-furfural called "Durite" is quite similar to Bakelite and avoided the Bakelite patents by use of furfural in place of formaldehyde. It is used by G-R-S in molding of motor commutators. In this instance it eliminates the use of mica and costly assembly operations.

1926 Alkyd resins, discovered by the General Electric Company and given the name "Glyptal" since it is made from glycerine and pthallic anhydride. Alkyds are used in varnishes, paints, enamels and lacquers in place of, or in combination with natural gums and resins to impart improved electrical characteristics and weather resisting properties. In signaling apparatus it is used in aluminum paint for outside of sheet metal, in enamels per AAR Signal Section Specification 227 for Target Enamels, and in varnish for coil impregnation.

1927 1929 Cellulose acetate, the material used in safety photographic film, is used in sheet form as coil insulation, tags, wire markers and also in place of glass for windows of cabinets. Clear transparent molded cellulose acetate called "Fibestos" was at one time used for relay covers but has been superseded by Tenite and Polystyrene.

1928 Phenol-formaldehyde casting resins are used in rod form in various colors for handles of switches, colored pushbuttons, etc. One of this type of material is called "Catalin".

1929 Urea-formaldehyde, a molding compound available in many different colors for pushbuttons and bulls eyes on control panels. Also is used an an adhesive in the manufacture of plywood. You no doubt know this plastic by the names "Beetle" and "Plaskon".

1932 1938 Cellulose acetate butyrate, better known as Kodapak II and Tenite II used in clear transparent form to mold transparent relay covers in place of glass. The resin is also used in manufacture of lacquer.

1936 1937 Methyl-methacrylate, a name hard to pronounce, is known as "Lucite" and "Plexiglass" and is used in place of glass for windows of cabinets, in rod form to polarize and conduct light and for some lenses.

1937 Lignin resin made from wood waste was developed by United States Government Forest Products Laboratory in Madison, Wisconsin. It is a low-priced material compared with laminated phenolic materials and is used where higher moisture absorption is not detrimental to its use. It is marketed under the name of "Consoweld".

1937 Styrene, one of the lowest priced resins, is made from coal tar and is sold under the name of polystyrene. It is easily molded by the injection molding method. It is the material now used for transparent relay covers.

1937 Nylon, a name familiar to all men who have wives or lady friends.
1942 Its major use in signaling apparatus is in the form of yarn in place of silk covering on magnet wire. In liquid form it is applied as an enamel on magnet wire in place of ordinary enamel. It is tough and elastic, has excellent electrical properties when kept dry. It has a valuable property called "memory". If you distort a piece of nylon, it remembers what shape it was originally and endeavors in time to return to that shape. That is one reason why the ladies like nylon stockings. After being stretched over a shapely "gam" and then removed for the night, the stocking returns closely to its original dimensions ready to be stretched again!! This property of memory is used in a small piece of nylon strip used as a clip to lock an insulator in place on B relay plugboards. It must be deformed in assembly and then recover its original shape to serve as a lock.

1928 Vinyl ester resins
1939 Vinylidene chloride
1940 Vinyl alcohol resin
1943 Vinyl carbazole resin

The above are the vinyl resins, which are widely used plastics, derived from acetylene made from coke. Vinyl resin is the material used in the manufacture of rain coats, shower curtains, garden hose and many household articles. In signaling apparatus it is used in tape form (Vinyl backed Scotch Tape) in place of friction tape and rubber splicing tape. Also vinylite spaghetti tubing is replacing varnished cambric tubing in many instances. On hook-up wire vinyl is being used in place of rubber insulation. Some of the trade names are Flamenol, Koroseal, Tygon and Vinylite.

1943 Silicone resin, one of the more recently used plastics in electrical apparatus, developed by the General Electric Company, is used as a coating on glass yarn tape and spaghetti tubing. It is resistant to high temperatures and is flame resistant. It is also used in the manufacture of "Silastic" a synthetic rubber like material and in the preparation of high temperature lubricants which seem to have quite constant viscosity over a wide range of temperatures.

1943 Polyethylene is a plastic material renowned for its high insulation resistance particularly at radio frequencies. It is used extensively as wire insulation in radio and communication circuits.

1946 Tetrafluoroethylene resin

1948 Chlorotrifluoroethylene resin

Try running those names off the end of your tongue. The first one is known by the trade name "Teflon" much easier to pronounce and remember. The second is known as "Kel-F", as made by the Kellogg Company. These materials are extremely high in cost at present but do have excellent electrical properties. Eventually the cost factor may be overcome by increased production. They have extremely high heat resistance with almost unbelievable toughness which makes them suitable for wire covering, gaskets and tubings. A plastic such as this, the water absorption of which is nil, which will not burn, which has excellent electrical insulation properties, will without doubt have many applications in signal apparatus when the cost becomes reasonable.

Since 1949 there have been no unusual plastics developed. The trend at present is to modify or improve existing plastics, reduce costs and broaden their usage.

The current popular plastics as used in signaling apparatus are:

1. The phenolics, such as Bakelite, in molded or laminated form.
2. Polystyrene, clear transparent moldings.
3. Vinylite, wire insulation and tubing.
4. Nylon, wire insulation and enamel.
5. Polyethylene, wire insulation.

There are two materials not listed in Table I that are truly plastics which you have been using for many years. They include Rubber and Vulcanized Hard Fiber.

Pure rubber for wire and cable insulation is fast being superseded by synthetic rubber and other plastics such as Nylon, Vinylite, Polyethylene and Neoprene (Polychloroprene).

To date, no other plastic material has been developed, at least no material comparable in price, to satisfactorily take the place of hard fiber for track joint insulation. Many other plastics have been tried but have been found wanting in some characteristic that fiber seems to fill satisfactorily. Nylon or Teflon might be OK except for price.

You may be interested to know where in signal apparatus plastics are now used and what materials they have replaced.

They have replaced metal, slate and porcelain for:

Relay top plates
Terminal Boards and
Terminal Blocks
Bushings and Insulators
Switchboards and panels

Plastics have replaced glass for:

- Bulls eyes and some lenses
- Windows in cases and cabinets

They have replaced cotton for:

- Magnet wire insulation
- Tape, coil coverings and
- Spaghetti tubing

Plastics have replaced fiber for:

- Coil spools
- Wire tags and markers
- Insulation for contact groups
- Washers
- Spacers
- Bushings
- Pushers
- Tubes and separators

Mica and shellac have been replaced by:

- Plastic molded commutators

Rubber, braid, jute and lead jacketed cable are being replaced by plastic insulated and plastic jacketed wire and cable.

Friction tape and splicing compound have been superseded in many instances by plastic tape of the Vinyl type.

The old linseed oil types of magnet wire enamel have been superseded by plastic enamels such as Formvar and Nylon.

Plastic coverings are being tried out for line wire insulation in place of braid and compounds.

In paints, enamels and varnishes, plastics are being used in place of or in combination with gums and natural oil and resins to increase corrosion protection. Glyptal and other alkyd resins are examples.

I have sufficient confidence in research and development to be willing to forecast that some day in the not too distant future:

1. A plastic material will take the place of fiber for track insulation. Nylon, Teflon, or Kel-F, or a modification are good bets. Very expensive now.
2. Relay housings, small ones at least, will be molded as a unit from plastics and larger housings, including bungalows, will be constructed of sheet plastic materials in place of steel.
3. Coils will be impregnated and molded in one operation in plastic compound in place of being taped and impregnated with compound or varnish.
4. Natural rubber insulation and lead sheath on wire will be superseded by synthetic compounds and plastics. The AAR Signal Section specifications for wire insulation are now tending in that direction with natural rubber as an alternate.
5. Signal lenses will be made from plastic material that will resist scratching and abrasion as well or better than glass.
6. Highway crossing signs will use plastic reflecting material in place of glass reflector units. The AAR Signal Section has already recognized the use of reflex-reflecting material made of tiny glass beads imbedded in a plastic sheet material.
7. Paints, enamels and protective compounds for metal surfaces will be greatly improved in the future by the use of synthetic resins and plastics. Alkyd resins are quite generally being used in paints, enamels and varnishes. Glyptal resin vehicle is in quite common use in paints especially for mixed on the job aluminum paints and in some varnishes.

Available plastics for use in signal apparatus are many. Their properties and characteristics vary greatly. The plastics industry is less than fifty years old. New and improved plastics will be developed. As they become available and their use justified economically you may be sure the signal apparatus manufacturers will use them.

* * *

NX INTERLOCKING AT FOSTORIA RETURNS 42% ON INVESTMENT

According to a report published by A.A.R. Signal Section, Committee I (Economics of Railway Signaling), the NX interlocking at Fostoria, Ohio, will pay for itself in 2-1/3 years.

Formerly trains on all four roads which crisscrossed through the town were required to make two stops in each direction. Signalmen were on duty 24 hours daily at 5 points, one of which was a mechanical plant.

Daily traffic consists of 133 through train movements, and an average of 180 switching movements.

The elimination of two stops per through train amounts to 97,090 stops yearly. Because trains today are occasionally stopped by another train on a crossing, the conservative estimate is that 91,250 stops are being eliminated yearly at a saving of 15 to 30 minutes per through train.

Freight train movements have been speeded up by 9,400 hours. There has been a reduction in pulled drawbars.

The net saving per year is $412,941. The annual return over 5% interest on the capital investment is 42.3%, and on the total cost 40.8%.

* * *

G-R-S NEWS
September 1951

In this issue:

New pushbutton machine for automatic switching
New retarder control machine
Combination machine for Eastbound Rutherford Yard
New design of sheet metal cases
Analyzer for coded track apparatus
New control machines
Installation photos of new B relay rack
G-R-S frequency-responsive speed governor

G-R-S NEWS
September 1951

NEW PUSHBUTTON MACHINE FOR AUTOMATIC SWITCHING

Ernest Norris Yard (Southern) and Kirk Yard (EJ&E) will be the first yards to use a new type of pushbutton machine (Figure 1) for automatic switching. Chief mechanical feature of the new design is the use of a pedestal structure which permits the machine to be placed directly on the floor of the hump office, eliminating the need for the table or desk required by earlier designs. The new machine, in addition to providing comfortable knee-room for the hump conductor, is equipped with a shelf for his switching list. This shelf, shown in Figure 1 on the right-hand side of the machine, may also be mounted on the left-hand side, or along the front of the machine. When mounted on the sides, the shelf may be horizontal as in Figure 1, or raised in the rear up to an angle of approximately 12 degrees. The shelf is fitted with a novel list holder, visible at the rear of the shelf in Figure 1. This device clamps the list in place by means of the magnetic attraction between the steel shelf and a permanent magnet mounted on a hinged plate. The list holder is also equipped with a small lamp for illuminating the list.

The panel of the machine contains the usual pushbuttons for routing cuts to the desired classification tracks, and also contains the control levers, with associated indication lights, for hump and trimmer signals, and for the scale switch. A new feature, however, is the built-in route storage indicator, shown in Figure 1 by the four small sub-panels at the top of the main panel. These sub-panels display, by means of lighted numerals, the routes stored in the system for cuts which have not yet reached the first switch. These route displays move across the four sub-panels from left to right, the same direction the cuts move in front of the conductor, so that the display at any given time corresponds with the positions of the cuts approaching the first switch. For a general description of the operation of route storage indicators see G-R-S NEWS for August 1951.

* * *

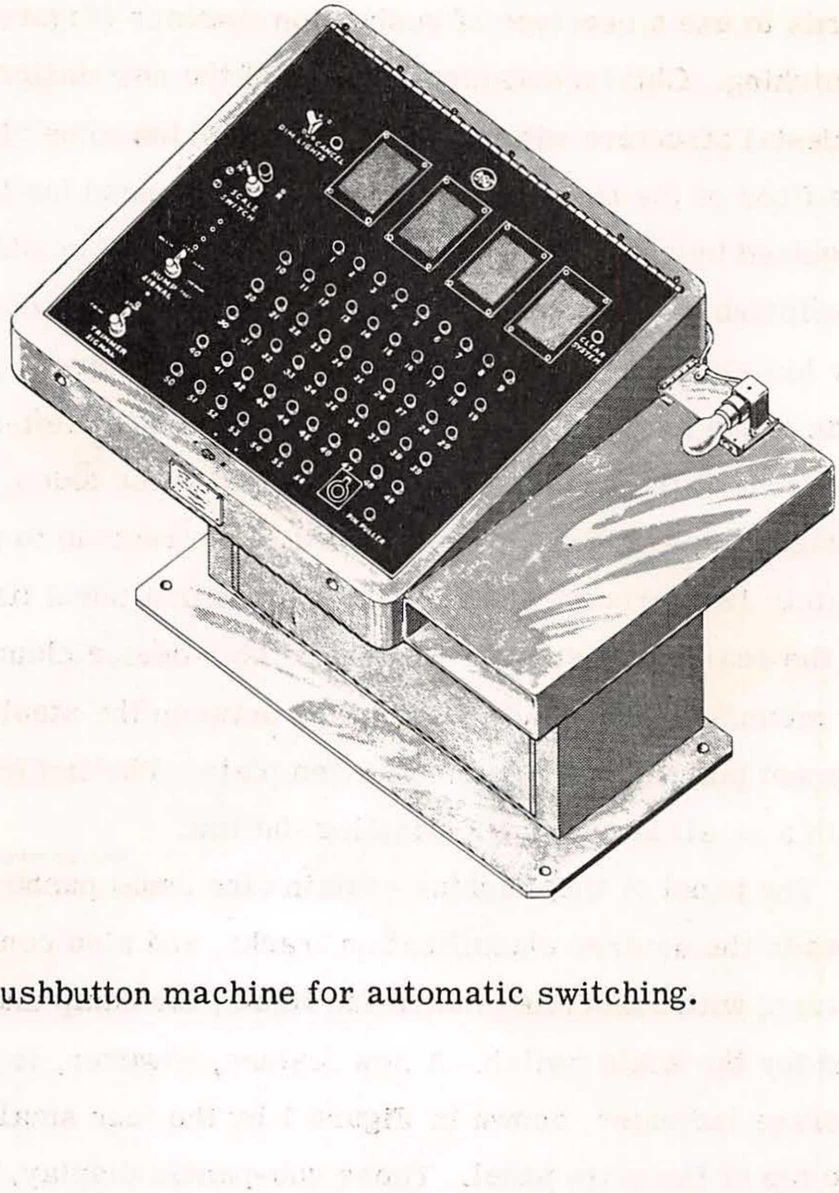
CANCEL
DIM LIGHTS
SCALE SWITCH
HUMP SIGNAL
TRIMMER SIGNAL
CLEAR SYSTEM
PIN PULLER

Figure 1. New pushbutton machine for automatic switching.

NEW RETARDER CONTROL MACHINE

Another new development is the adoption of a T-shaped arrangement for retarder control machines. With this design (Figure 2) the operator sits facing the leg of the T, with the retarder controls — the most actively used levers on the machine — concentrated directly in front of him, while the track diagram and associated controls fan out over the cross-bar of the T, but still within convenient reach when required.

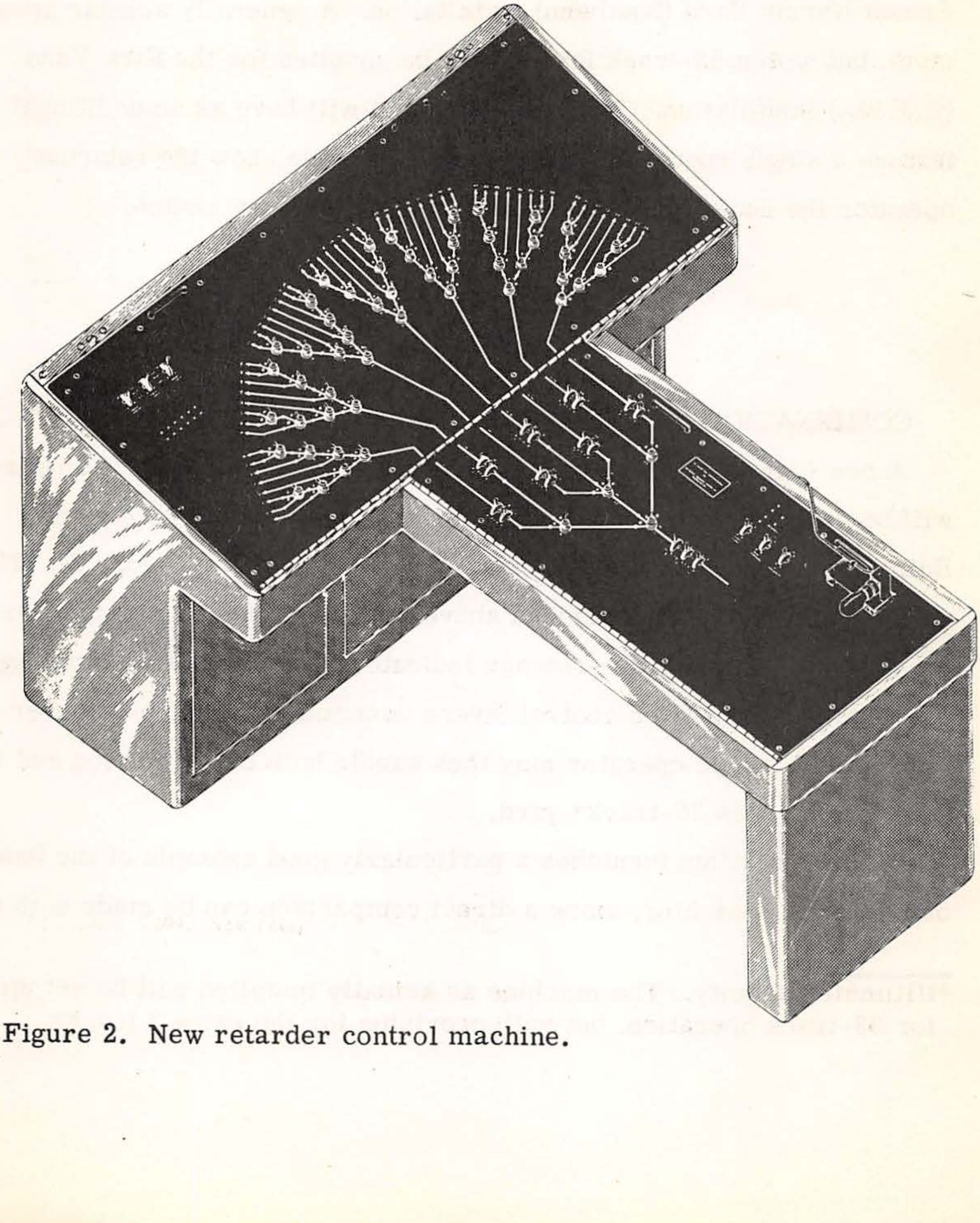

Figure 2. New retarder control machine.

As shown in Figure 2, a magnetic list holder and lamp combination, similar to that described for the pushbutton machine, may be supplied with the retarder control machine. In this case, since the panel is of our standard laminated phenolic material, the necessary magnetic action is obtained by mounting a small steel plate on the under side of the panel.

Figure 2 shows the new machine as it will be laid out for the 56-track Ernest Norris Yard (Southern) installation. A generally similar arrangement, but with a 58-track layout, will be supplied for the Kirk Yard (E.J.&E.) installation. The latter machine will have as an additional feature a single route-storage indicator panel to show the retarder operator the route for the next car entering the first switch.

* * *

COMBINATION MACHINE FOR EASTBOUND RUTHERFORD YARD

A new high in efficient operation of the smaller classification yard will be obtained with the concentration of control built into the new Rutherford Yard Eastbound (Reading) control machine (Figure 3). This unit uses the T layout described above, and combines, in a single machine, the pushbuttons and route-storage indicators for automatic switching with the retarder and switch control levers customarily found on a tower machine. A single operator may thus handle both classification and retardation for this 36-track* yard.

This installation furnishes a particularly good example of the benefits of automatic switching, since a direct comparison can be made with the

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*Ultimate capacity. The machine as actually installed will be set up for 33-track operation, but with provision for the extra 3 tracks.

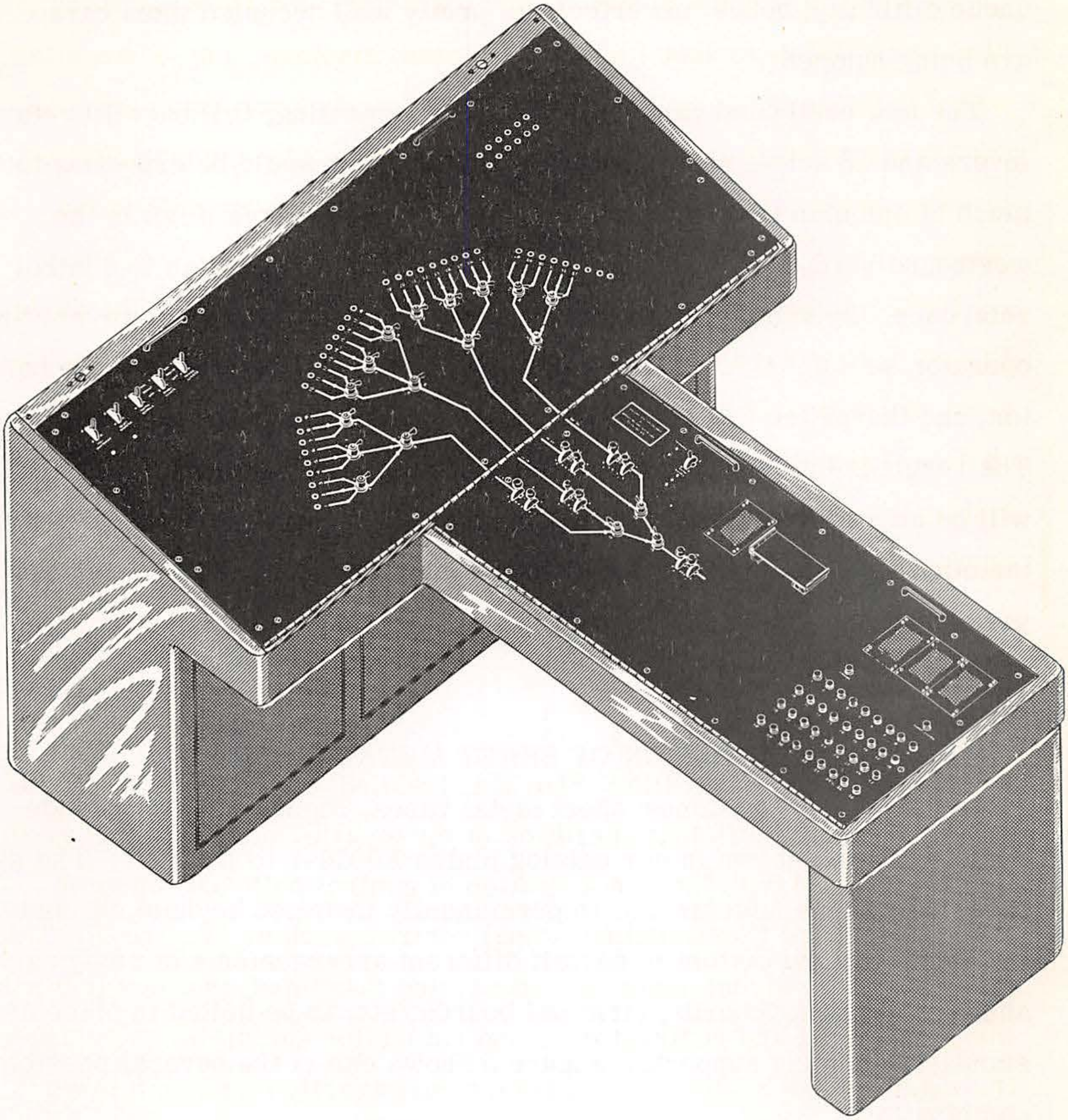


Figure 3. Combination machine for Eastbound Rutherford Yard.

adjacent Rutherford Westbound Yard. The latter yard is an excellent example of a modern small (18-track) retarder yard, carefully planned and constructed. Because of its size, this yard can be handled manually by a single operator using a G-R-S control machine with nine switch levers and five retarder levers. The operator handles the job without undue difficulty, but is, nevertheless, pretty well occupied when cars are being humped.

The new eastbound yard, with 33 tracks operating, will have 10 retarder levers and 18 active switch levers. Obviously, it would be expecting too much of one man to operate the machine for such a yard if, as in the westbound yard, he had to line up routes manually as well as to control retarders. By equipping the yard with automatic switching, however, the operator sets up the complete route for each cut by pushing a single button, and thereafter can devote his entire attention to retarder operation. The result is that a single operator, with the aid of automatic switching, will be able to handle the 33-track eastbound yard with as much ease as the other operator handles the 18-track manually-controlled westbound yard.

* * *

NEW DESIGN OF SHEET METAL CASES

G-R-S has designed new sheet metal cases, Figure 4, to supersede the 56101 types shown in our catalog plates E0970-1 to E0976-1. The new cases will be manufactured with permanently installed keyhole channels in the sides, top and bottom to permit different arrangements of relay racks, shelves, mounting boards, terminal boards, etc. to be bolted in place using standard mounting supports. Figure 5 shows one of the several possible combinations.

The cases are also equipped with movable rectangular keyhole channels as shown in Figure 6. They are bolted to the permanently installed top and bottom channels at any point where necessary.

To allow room for cable runs the new design for the instrument cases features a higher roof than the older models. Rear doors will be furnished with handles for padlocking. There are two aerial cable entrance knockouts on both ends of the case.

The following sizes are planned for manufacture:

WIDTH	HEIGHT	DEPTH
2' 7-1/2"	4' 8-7/8"	23"
4' 11"	4' 8-7/8"	23"
3' 3-1/2"	6' 6-3/8"	23"
4' 11"	6' 6-3/8"	23"
6' 9"	6' 6-3/8"	23"
9' 8"	6' 6-3/8"	23"

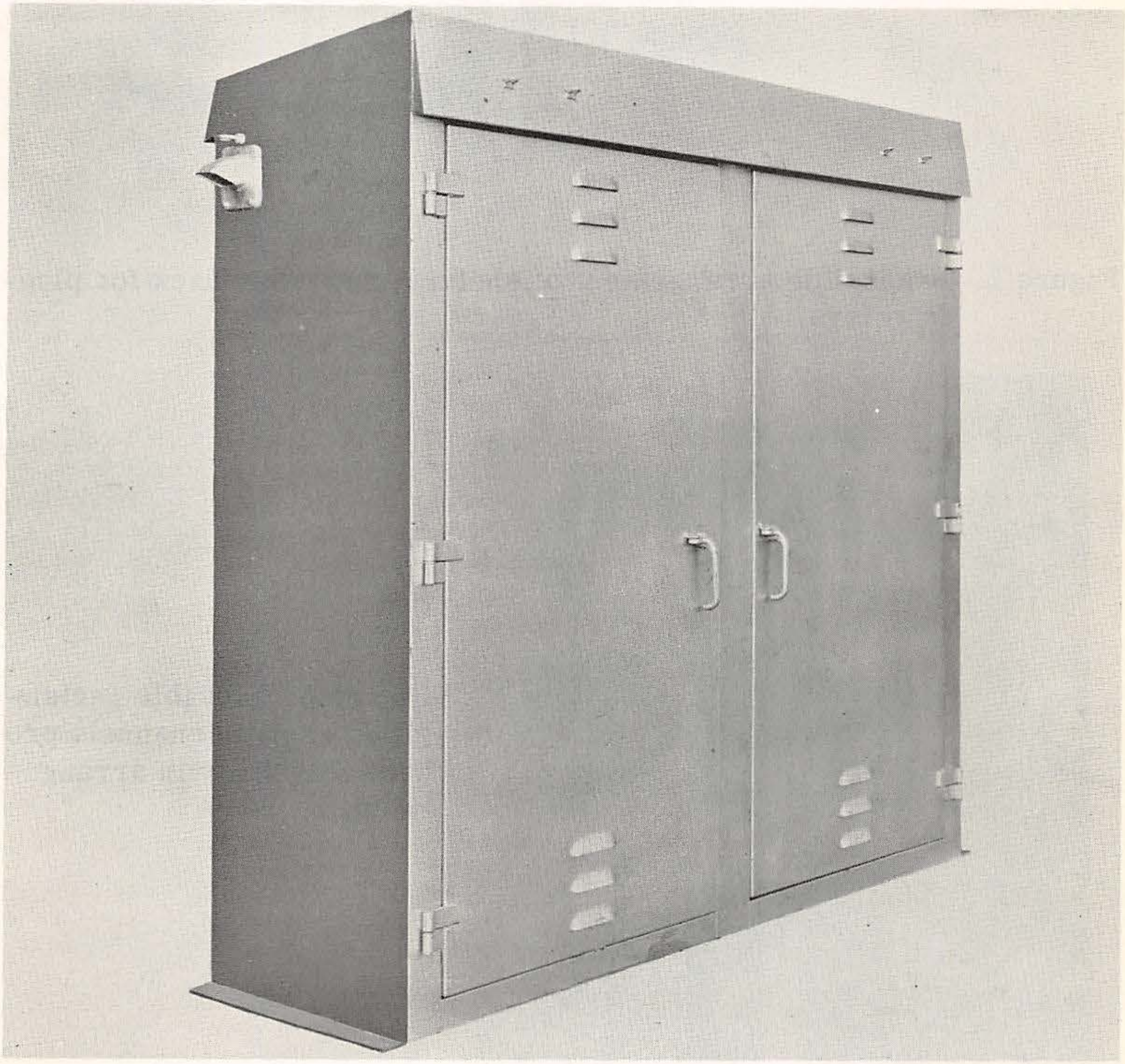


Figure 4. New case features a higher roof to provide more room for wiring.

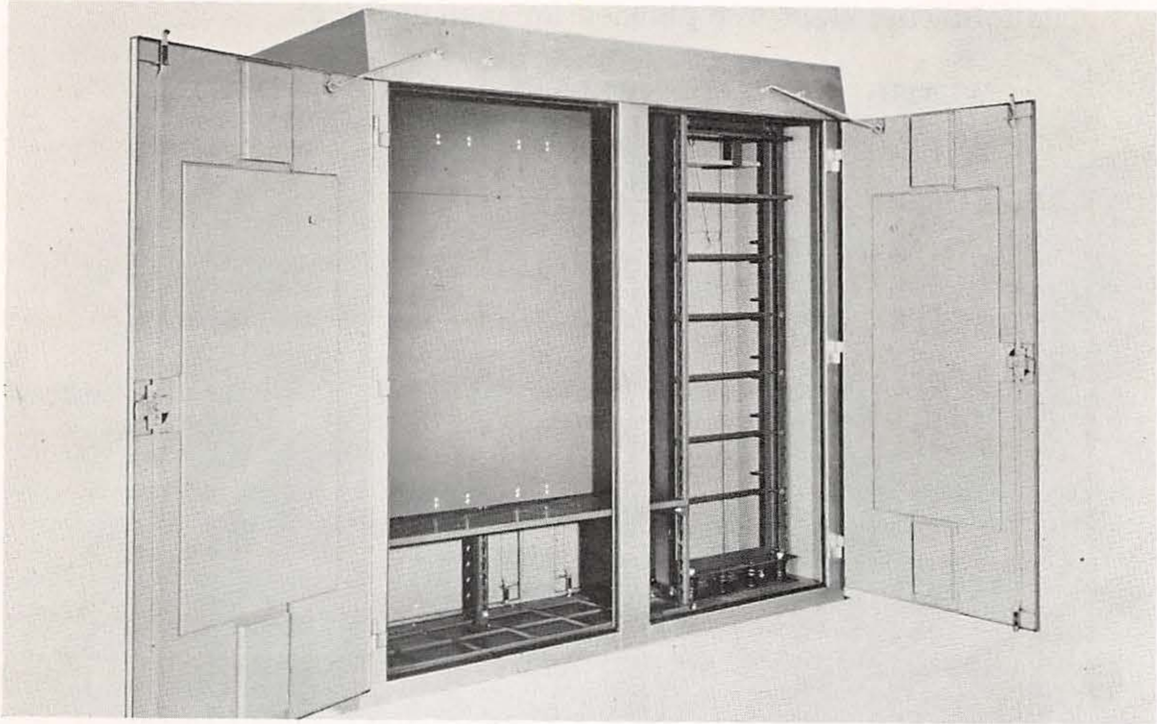


Figure 5. A possible arrangement of shelving and relay rack for plug-in relays.

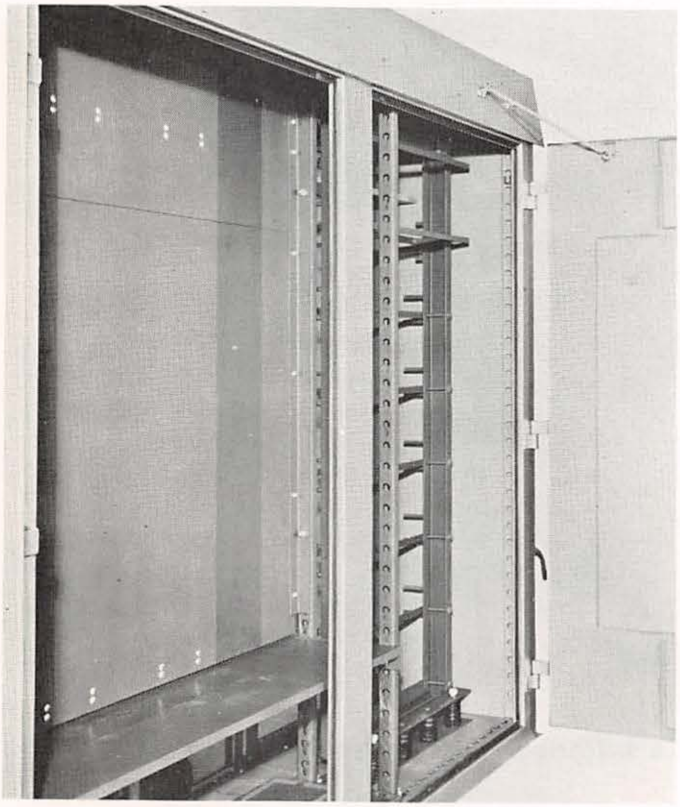


Figure 6. Movable rectangular keyhole channels provide flexibility in arrangement.

ANALYZER FOR CODED TRACK APPARATUS

G-R-S has recently developed a code analyzer for testing wayside coded track apparatus, Figure 7. The analyzer provides a full range of standard and test code rates. A built-in relay, driven by any of the code rates, can be adjusted for various "on" times as may be required for testing purposes. The analyzer can be used to check code transmitters, decoders, and the "on" time of any coding contacts.

A 110-volt, 60-cycle, a-c. synchronous motor generates code rates at 225, 180, 150, 120, 105, and 75 per minute. The 225, 150, and 105 rates are for testing decoders. Neon test lights show the nature and the amount of divergence of the code rate being tested from the standard.

The analyzer weighs 14 pounds and is housed in a fiber-covered plywood case 14-3/4" wide, 9-7/8" deep, and 5" high. The case has a carrying handle and compartment for leads. Requiring no batteries, the analyzer plugs into any 110-volt, 60-cycle a-c. outlet.

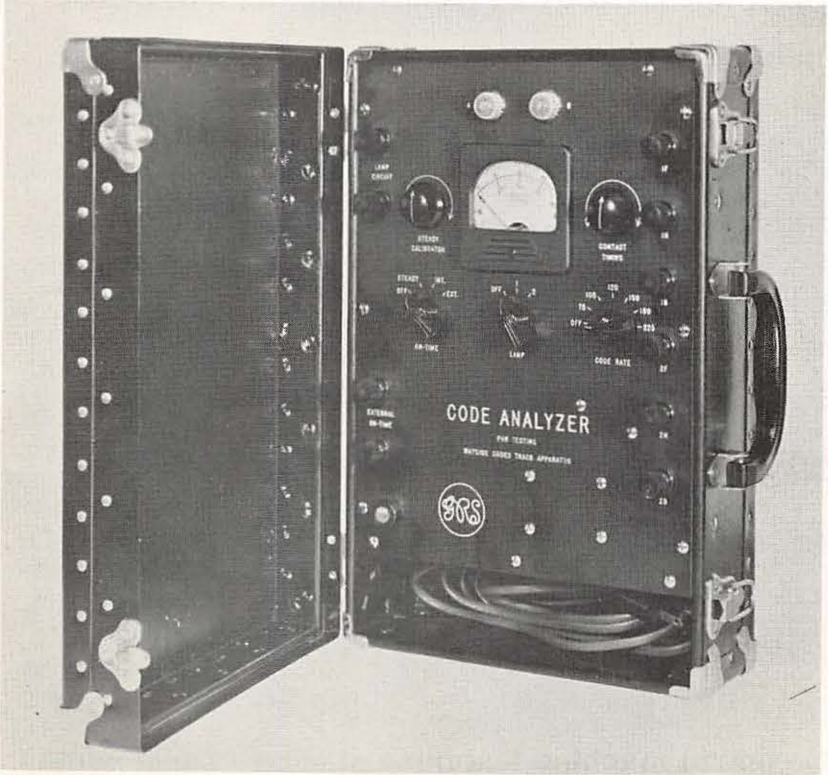

LAMP CIRCUIT
STEADY CALIBRATOR
STEADY
INT.
OFF
EXT.
ON-TIME
OFF
2
LAMP
120
105
150
75
180
OFF
225
CODE RATE
EXTERNAL ON-TIME
CODE ANALYZER
FOR TESTING
WAYSIDE CODED TRACK APPARATUS
GRS

Figure 7. Analyzer for coded track apparatus.

NEW CONTROL MACHINES

Redesigned Type C control machines for signal control systems have been developed featuring standard panel widths, Figure 8.

All machines, with the exception of those used in cTc control, will be furnished in five standard panel widths, 18, 36, 54, 72, or 90 inches. If machines of greater length are required, a combination of these standard widths can be used. Wing type machines will have the same choice of panel widths for each wing.

Machine depth has been increased 2 inches and now measures 16 inches overall. Shelves and other horizontal assemblies will be precut to five standard lengths. Shelf height will be 32 inches. Access doors on the front and the back of the machine have been increased in overall size. Each door is removed by loosening two fasteners at the top and pulling back and up on the handle.

The overall machine height will be either 5 feet or 5-1/2 feet. Operating panels on 5-foot machines will be 24 inches high; on 5-1/2-foot machines, 30 inches high.

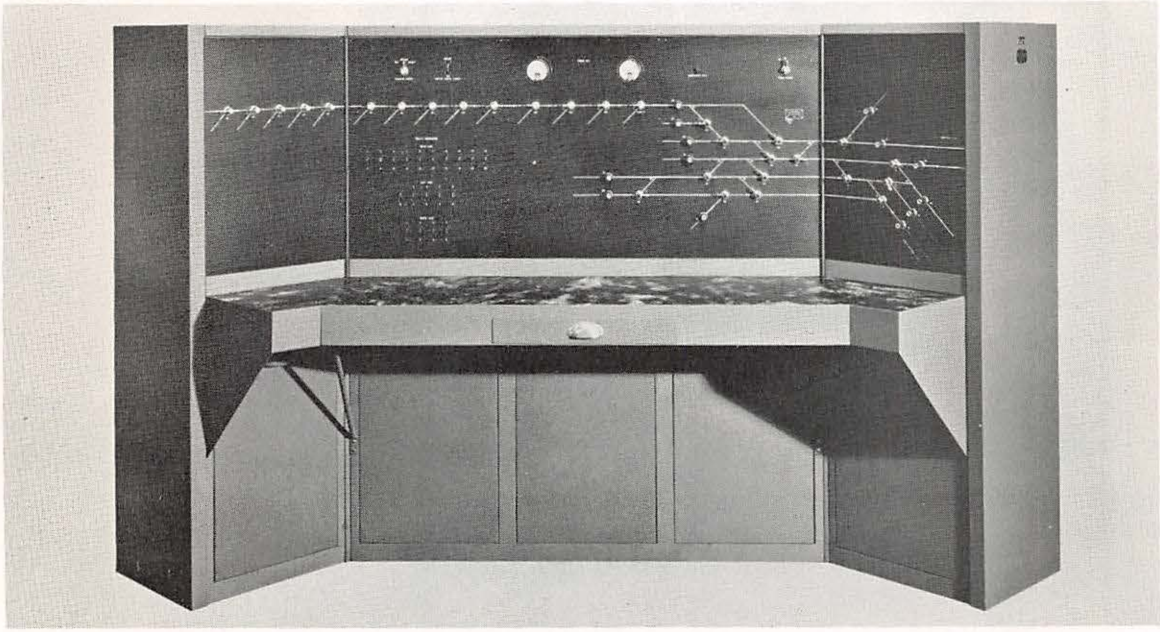


Figure 8. New Type C control machine featuring standard panel widths.

INSTALLATION PHOTOS OF NEW B RELAY RACK

Supplementing information on our new Type B rack given in June 1951 G-R-S NEWS, here are some photos made of the installation on the Hillside Avenue extension of the B. of T. at 179th Street Interlocking, CM5632.

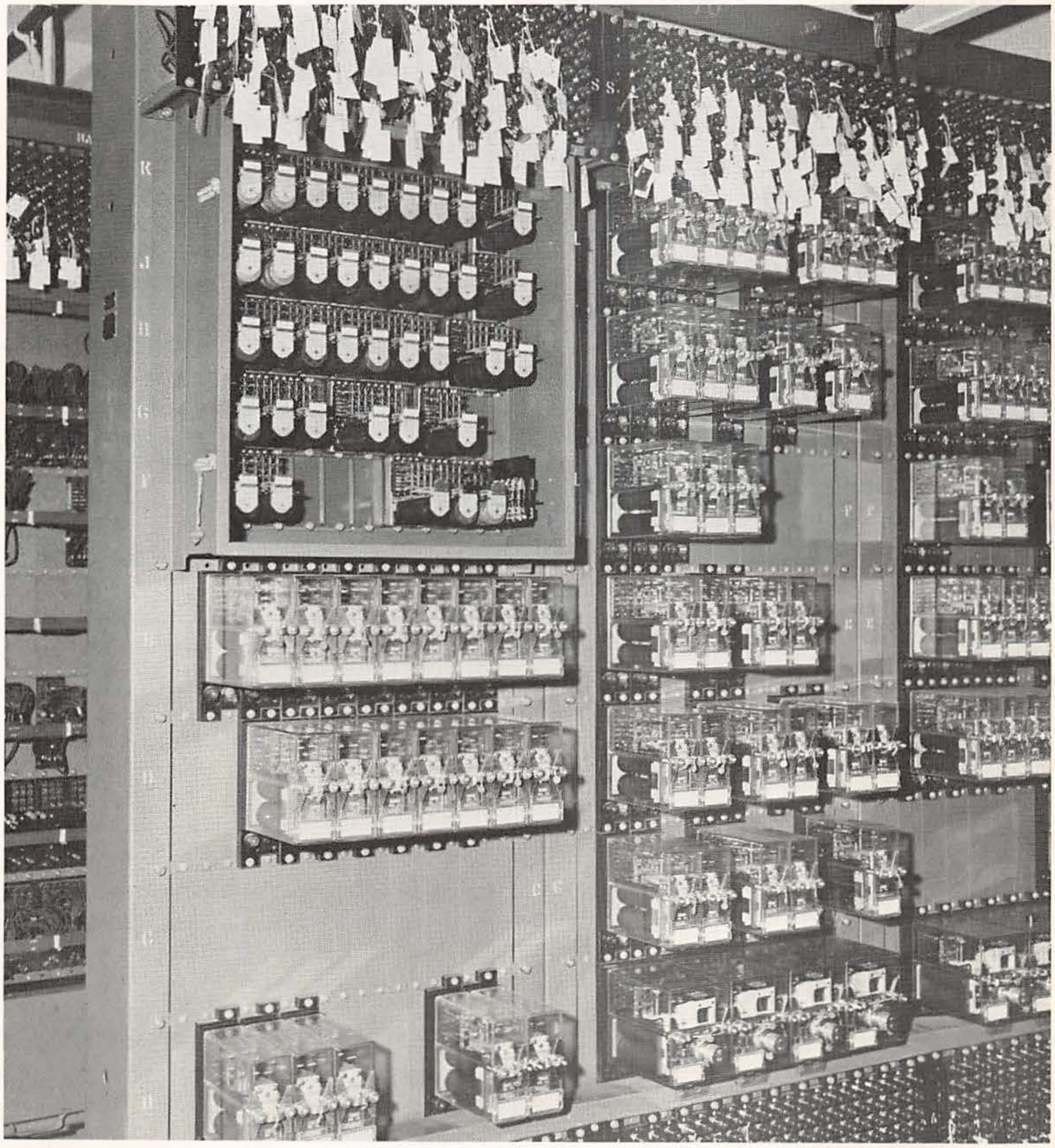


Figure 9. New rack showing Type A relay cabinet and Type B relays installed.

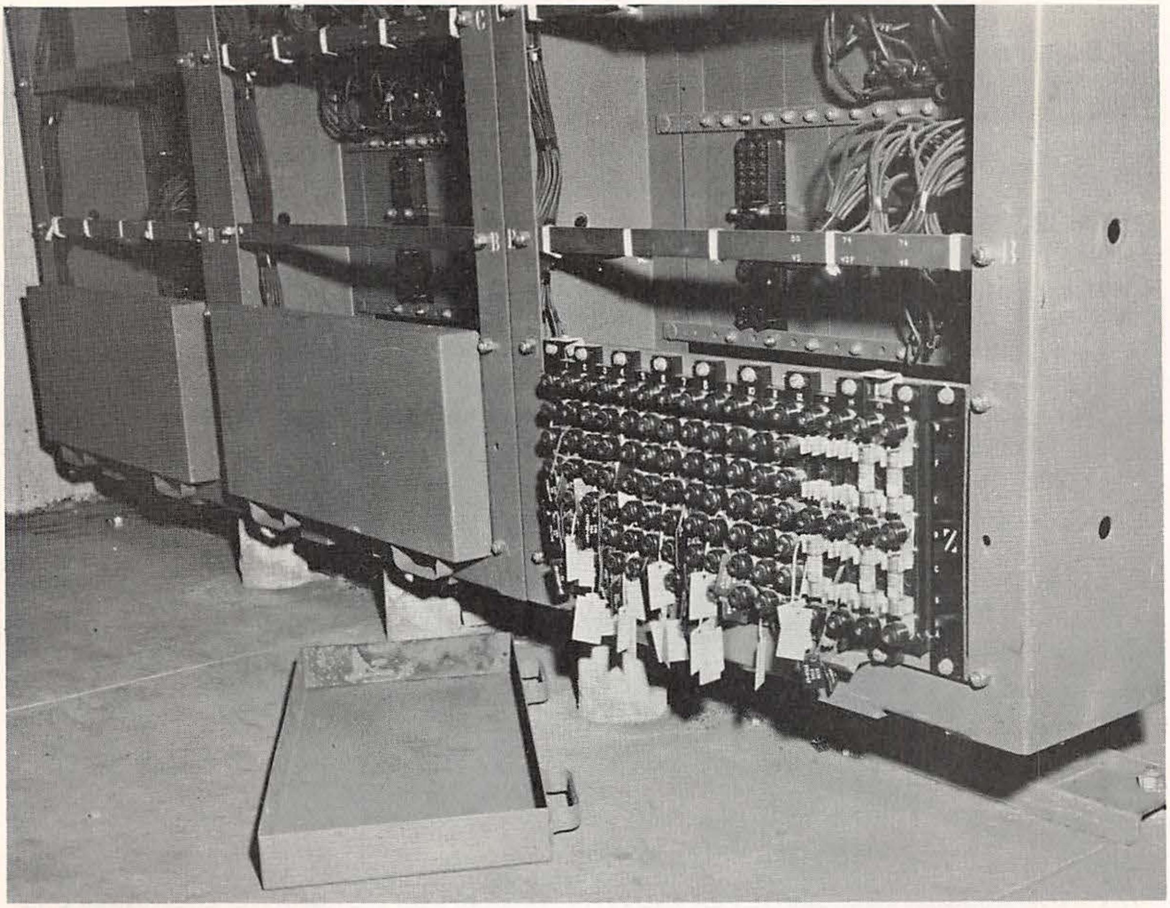


Figure 10. Protective covers for terminal boards at bottom of rack.

NOTE

The following article describes a new device which is now undergoing tests in actual railroad operation.

Since the device is new and not in production, it should not be discussed with railroad personnel without good reason.

* * *

G-R-S FREQUENCY-RESPONSIVE SPEED GOVERNOR

General

The G-R-S Frequency-Responsive (FR) Speed Governor (Figure 1) is a new development in the field of train-speed determination for control purposes. This governor uses the variation in frequency produced by a simple axle-driven generator as an indication of varying train speed. By applying the output of the generator to a suitable amplifier, filter, and relay arrangement the governor determines when train speed exceeds a pre-established value, and so may be used to control the functioning of associated train-control equipment. The governor may be arranged for simple over-speed operation, with a single high-speed limit, or it may be used to provide over-speed operation at any number of intermediate levels as required by signal indications.

Design Features

The FR governor is designed to provide accurate, dependable operation with minimum maintenance requirements. Among its features are the following:

1. Axle-driven generator is a simple, lightweight rotor-stator assembly housed in a compact case mounted on the locomotive journal box. No flyweights, springs, gears, brushes, commutators or contacts are used in this unit, and only two wires are needed for connection

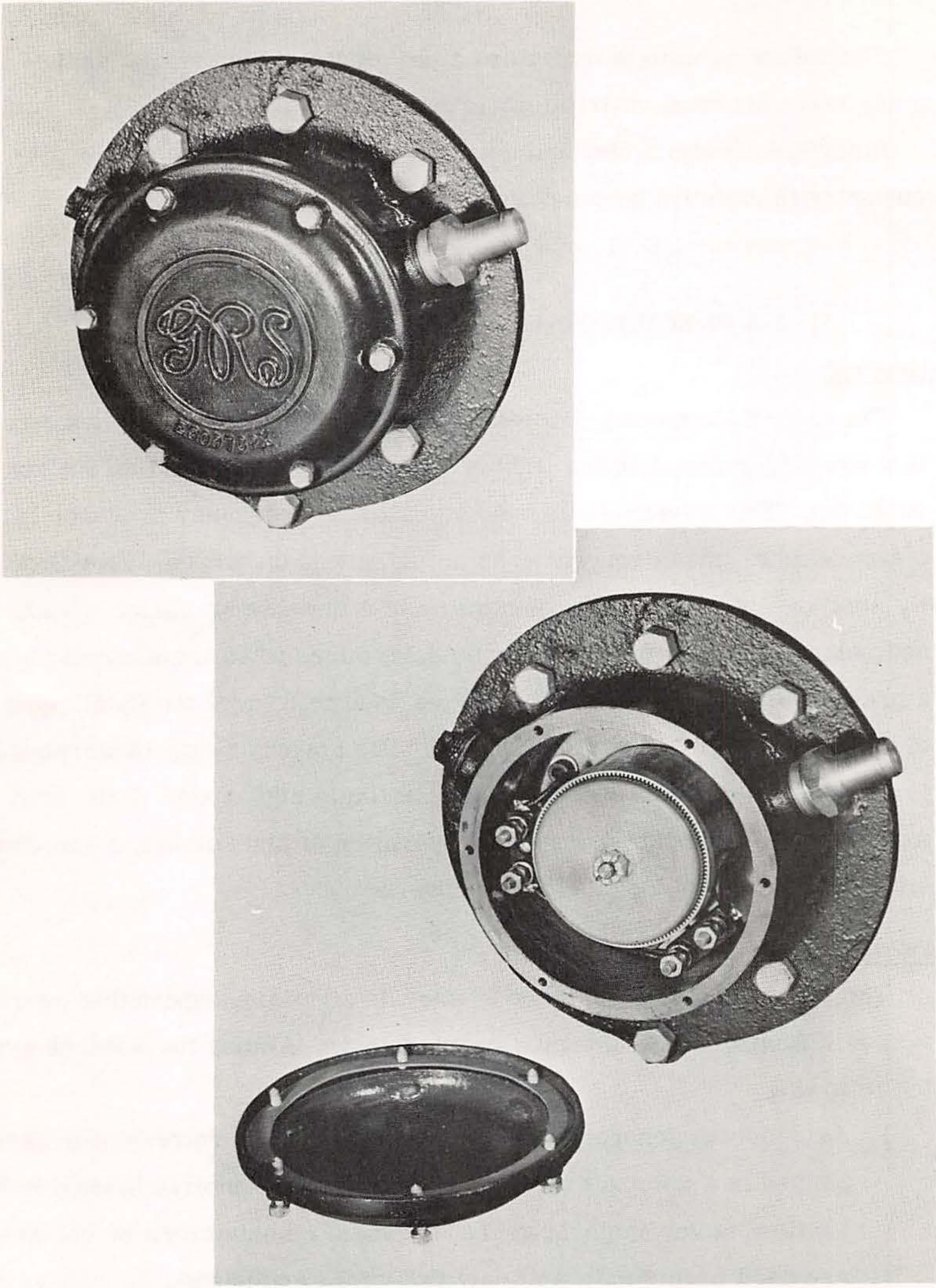


Figure 1. G-R-S frequency-responsive speed governor.

to the locomotive equipment. Maintenance requirements are limited to occasional lubrication of two bearings; no adjustments are necessary.

2. System is purely frequency responsive. Output frequency at any speed is entirely determined by the number of poles on the generator and the r.p.m. of the axle. Variations in output voltage caused by temperature, aging, etc., have no effect on accuracy.
3. A single over-speed contact, the front contact of a standard relay mounted in a mechanism case in the locomotive cab, is used to enforce all speed limits. No mechanically actuated speed-responsive contacts are used.
4. Required shop tests may be made with all major components in place by injecting a suitable electrical signal into the system from a simple test device. It is not necessary to provide mechanical rotation of the axle generator, nor to uncouple it from the axle.
5. Wheel wear compensation is made by means of a single multiple-position switch in the mechanism case. No mechanical adjustments or changes need be made in the apparatus.
6. The circuit arrangement used for the governor is completely self-checking. The system must be intact and in proper working order before associated brake control equipment can be released.
7. An auxiliary speedometer may be added to the system to provide continuous speed indications which are consistent with the speed limits imposed by the governor. The same axle generator used for over-speed determination is used for the speedometer. Speedometer performance may be accurately tested by electrical means while locomotive is standing in the shop, and without the removal of any components.

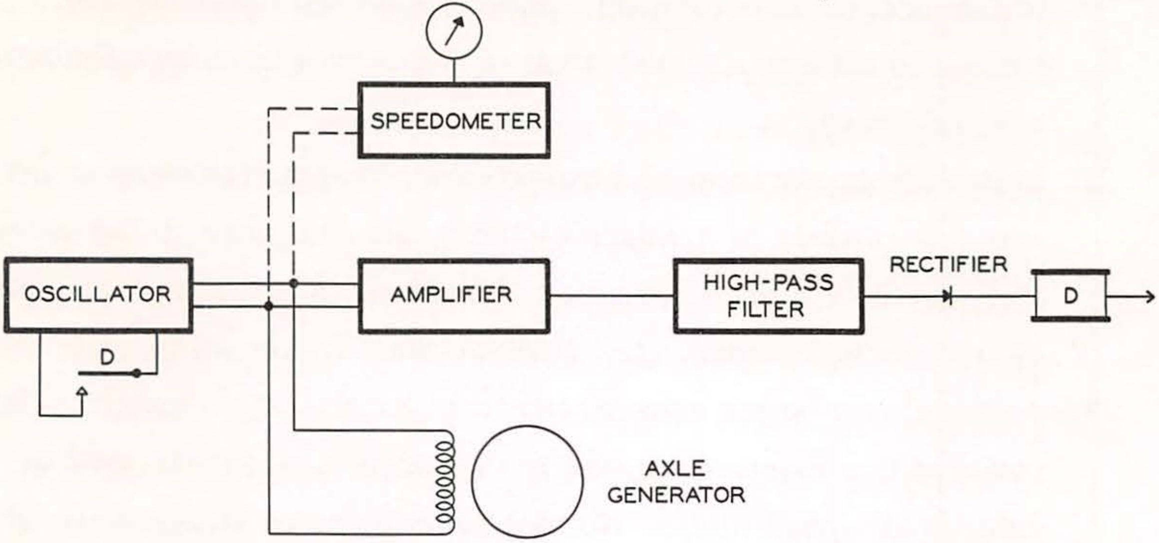


Figure 2. Block diagram.

Principle of Operation

The basic principle of operation of the FR governor is illustrated in the block diagram, Figure 2. The high-pass filter passes frequencies above a pre-determined cut-off value, and blocks frequencies below this value. The oscillator produces an a-c. output of sufficiently high frequency to pass through the high-pass filter, after amplification in the amplifier. This amplified oscillator output, after passing through the filter, is rectified and used to energize relay D. When relay D picks up, it quenches the oscillator, removing the input to the amplifier. Relay D thereupon drops away, re-starting the oscillator, again picking up relay D, and so on. This cycling action of relay D continues as long as train speed does not exceed the authorized maximum.

The axle generator develops an a-c. output whose frequency, because of the mechanical configuration of the device, must be directly proportional to train speed. This output is fed to the amplifier in parallel with the signal from the oscillator. The amplifier, in turn, feeds an amplified output, at axle-generator frequency, to the high-pass filter. As long as the axle-generator frequency is below the cut-off value of the filter —

i.e., as long as train speed is below the permissible limit — the axle-generator frequency does not reach the rectifier and the cycling of relay D is not affected. When train speed exceeds the limit, however, the axle-generator frequency goes above the cut-off value, and amplified output at this frequency is fed to the rectifier. The rectified output then holds relay D energized, so that the cycling operation stops. When this occurs, associated speed-control equipment takes action appropriate to the over-speed condition.

Since the speed limit imposed by the governor depends upon the cut-off value of the high-pass filter, the FR governor may be arranged, in conjunction with appropriate auxiliary equipment, to provide multiple values of the speed limit by arranging the circuits to switch appropriate high-pass filters into the system in accordance with signal indications.

GENERAL RAILWAY SIGNAL COMPANY

G-R-S NEWS
August 1951

In this issue:

New dragging equipment detector

Route storage indicators for automatic switching

The American wire gauge table

G-R-S NEWS
August 1951

NEW DRAGGING EQUIPMENT DETECTOR

The G-R-S self-resetting dragging equipment detector, originally described in the November 1947 issue of G-R-S NEWS, has recently been completely redesigned.

The new detector, Figure 1, consists of a 3-1/2-inch O.D. steel pipe extended into bronze sleeve bearings in two end compartments. Individual blade sections approximately 12-1/2 inches long are fastened to the pipe with through bolts, 3 to a blade. Thus each blade can be replaced separately should it be damaged. Blades come in various heights, depending on individual railroad's clearance requirements. Specially shaped blades are available for retarder protection. Blades are 12-gauge steel, case hardened.

The end compartments contain the bearings for the pipe, the contact, and the torque-adjusting device. Each compartment is spring mounted on its supporting bracket. Brackets may be bolted or lagged to ties.

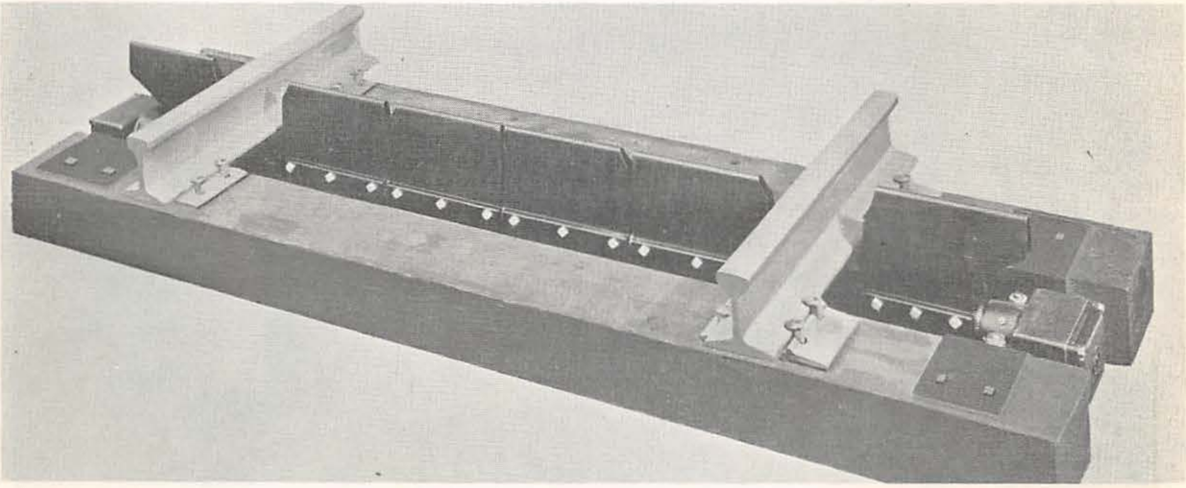


Figure 1. G-R-S self-resetting dragging equipment detector.

Figure 2 shows the torque-adjusting compartment, and Figure 3 shows the contact compartment.

The square rod with the cotter pin showing in each compartment is the torsion bar that returns the blades to their upright position whenever they are deflected by dragging equipment - regardless of direction of operation. This bar is made of heat-treated, cold-drawn steel.

The torsion bar extends through the center of the pipe and is fastened at one end to a crank, Figure 4, and at the other end to an adjusting sector, Figure 5. A coil spring, bearing against a washer holds the parts along the torsion bar from moving laterally.

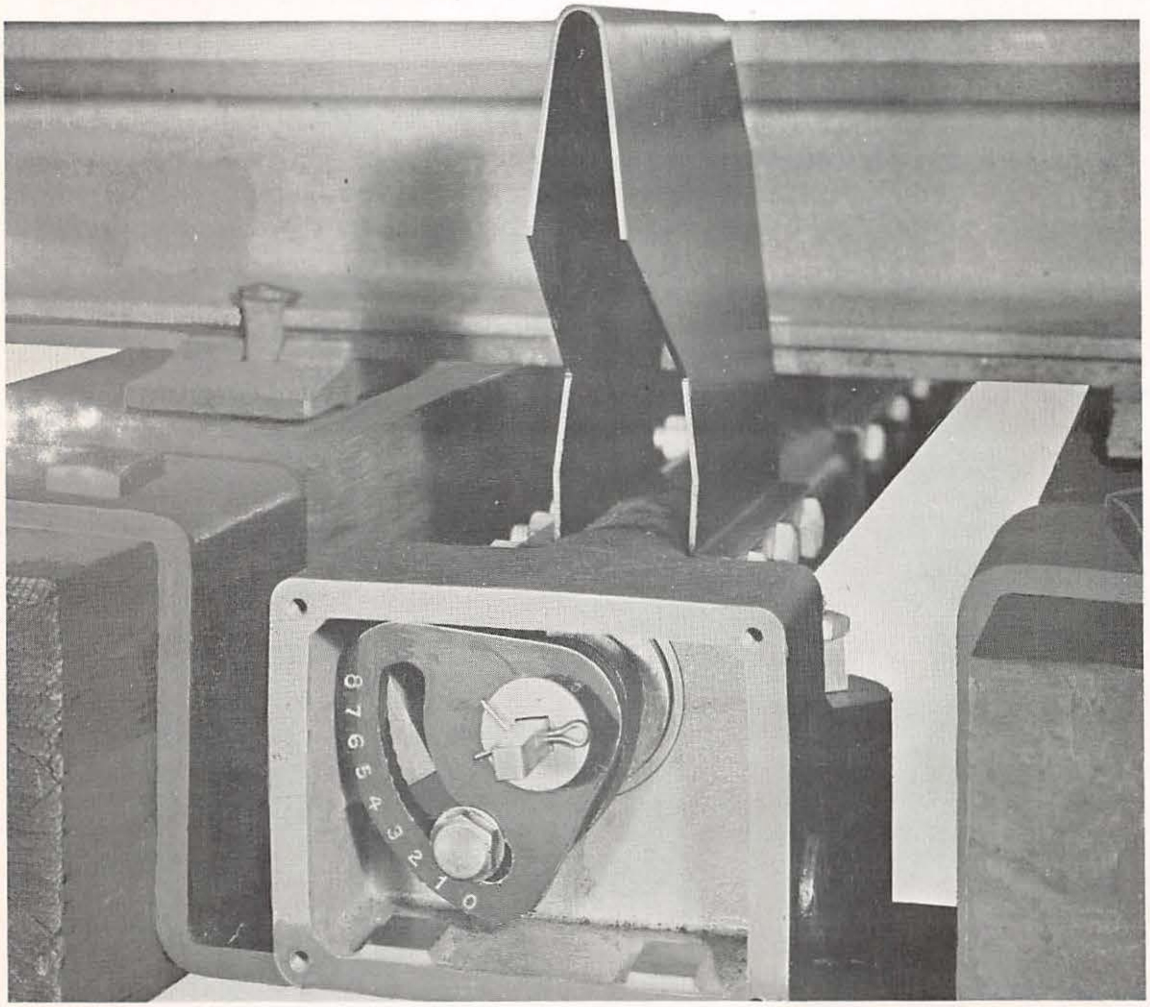


Figure 2. Torque-adjusting compartment.

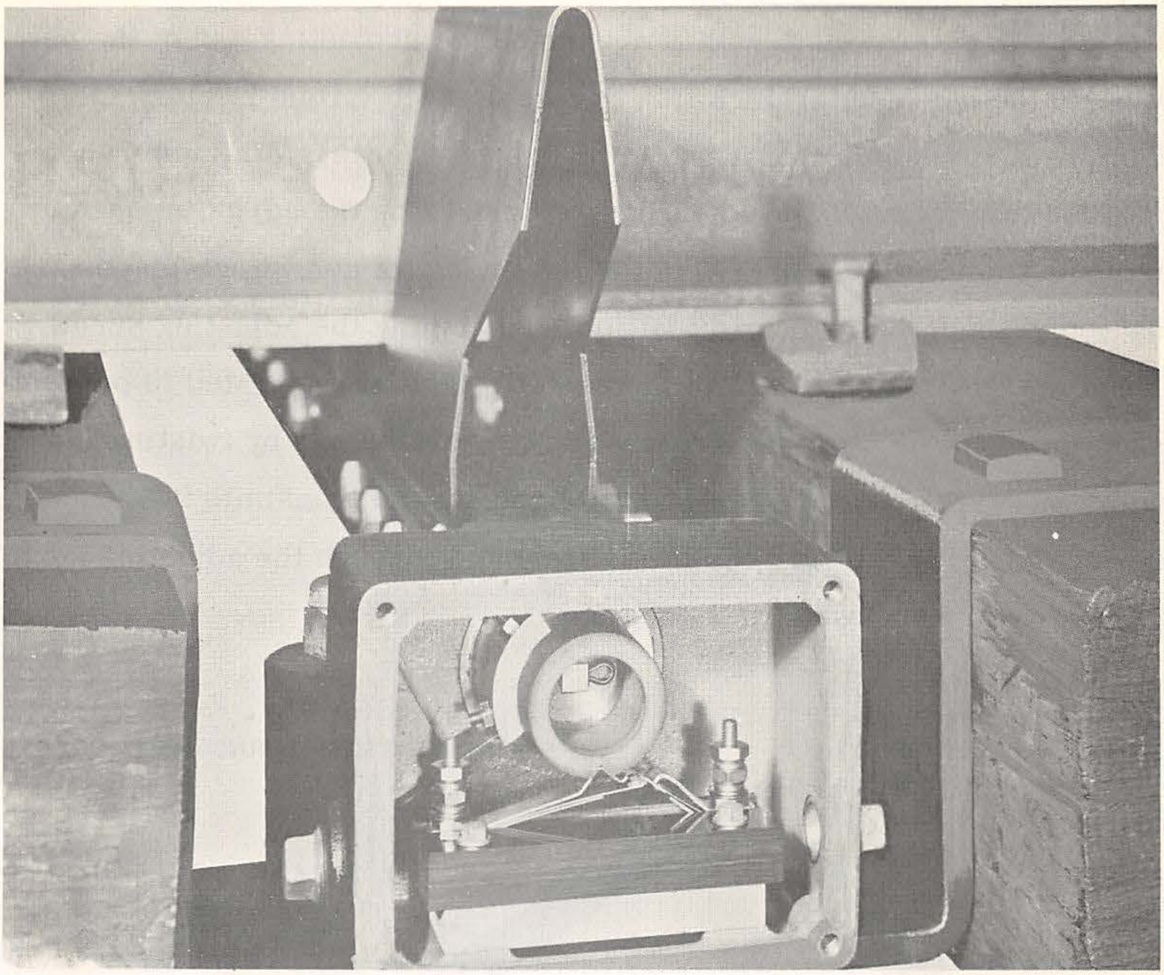
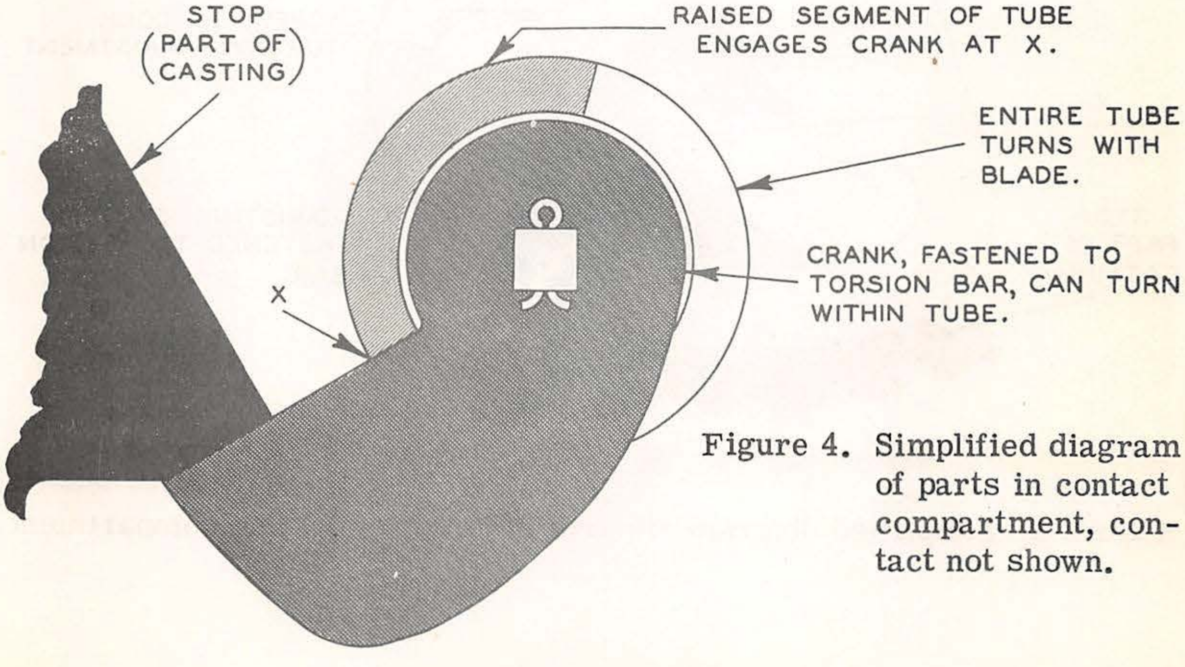


Figure 3. Contact compartment.



STOP
(PART OF CASTING)
RAISED SEGMENT OF TUBE ENGAGES CRANK AT X.
ENTIRE TUBE TURNS WITH BLADE.
CRANK, FASTENED TO TORSION BAR, CAN TURN WITHIN TUBE.
X

Figure 4. Simplified diagram of parts in contact compartment, contact not shown.

Referring to Figure 5, the blades are initially adjusted by loosening the adjusting screw and, with a wrench on the projecting end of the bar, turning the bar counterclockwise till the desired torque is reached. Torque is adjustable from zero to 800 pound-inches. Minimum recommended torque is 200 pound-inches. Numbers on the adjusting sector indicate the torque setting. Torque increases, of course, as blades are deflected from their upright position. Tightening the adjusting screw locks the crank in Figure 5 to the sector - they are serrated to prevent slippage. Now the torque developed in the torsion bar by twisting it with the wrench is stored as potential energy and transmits its thrust through the crank to the stop in Figure 4 and through the adjusting sector, to the crank, to the stop in Figure 5.

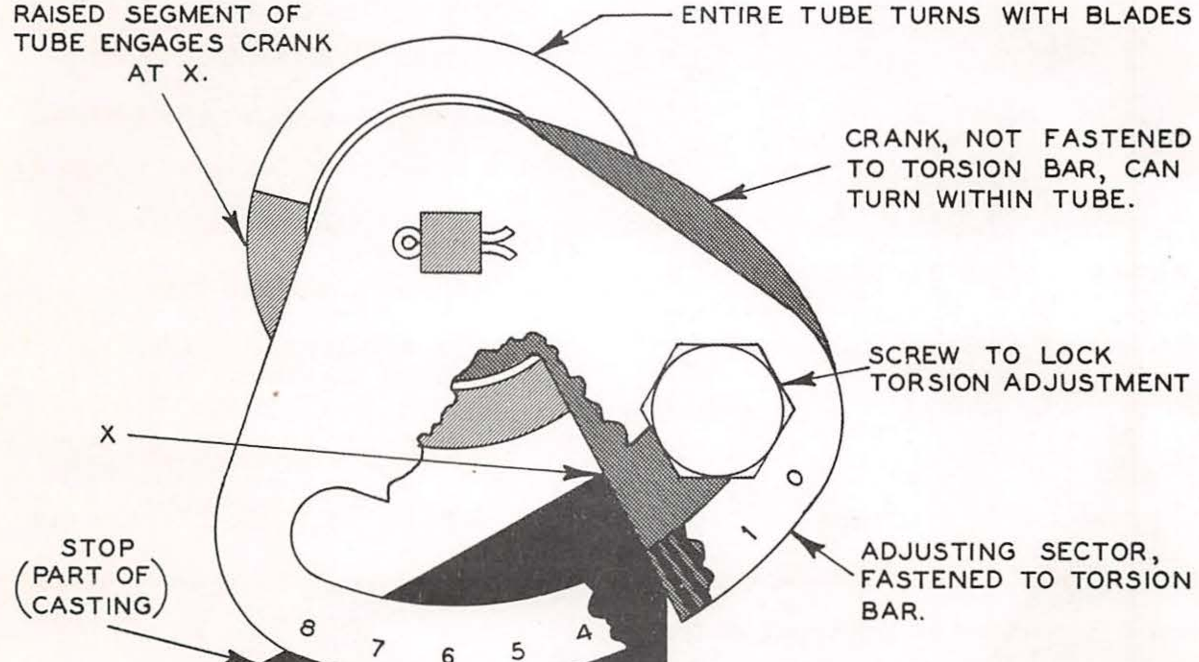

RAISED SEGMENT OF TUBE ENGAGES CRANK AT X.
ENTIRE TUBE TURNS WITH BLADES
CRANK, NOT FASTENED TO TORSION BAR, CAN TURN WITHIN TUBE.
SCREW TO LOCK TORSION ADJUSTMENT
X
0
1
ADJUSTING SECTOR, FASTENED TO TORSION BAR.
STOP (PART OF CASTING)
8
7
6
5
4

Figure 5. Simplified diagram of parts in torque-adjusting compartment.

Where the pipe carrying the blades extends through the bearings at either end, it is reduced in diameter. This is done by welding two short tubular sections of cold-drawn steel into either end of the main pipe. The ends of these tubular sections are machined down for 225 degrees of their circumference, leaving raised segments as indicated in Figures 4 and 5 (you can see this segment quite clearly in Figure 3). Thus, whichever way the pipe rotates when struck, a raised segment will transmit additional torque to the torsion bar at points X, Figures 4 and 5. As soon as the dragging equipment frees the blades, the potential energy in the torsion bar will again bring the blades to their upright position.

The torsion bar is easily replaced. It is only necessary to relieve the torsion on the bar by loosening the adjusting screw and letting off the torque while holding a wrench on the projecting end of the bar. As soon as the torsion has been released the cotter pin on the end of the bar nearest the spring is removed and the bar withdrawn. Replacing the bar is a matter of assembling the cotter pin, washer and spring on one end and sliding the other end through until the cotter pin can be inserted in the hole. The torque is adjusted as described previously.

The contact arrangement, Figure 3, consists of a notched tube of laminated phenolic material bolted to the tubing segment. The V-shaped projection on the phosphor-bronze spring contact finger is normally in the notch in the phenolic tube. Any movement of the blades more than approximately 5° rotates the phenolic tube, forces the contact finger out of the notch, and opens the normally closed contact. The contact arrangement is located at the front of the compartment in plain view of anyone adjusting or inspecting the mechanism.

Figure 6 shows a typical layout, Drawing No. 58451-3. Wiring entrances, one on either side of the contact compartment, are 3/4-inch pipe thread, shipped with plugs. Specify cable entrance adapter separately.

* * *

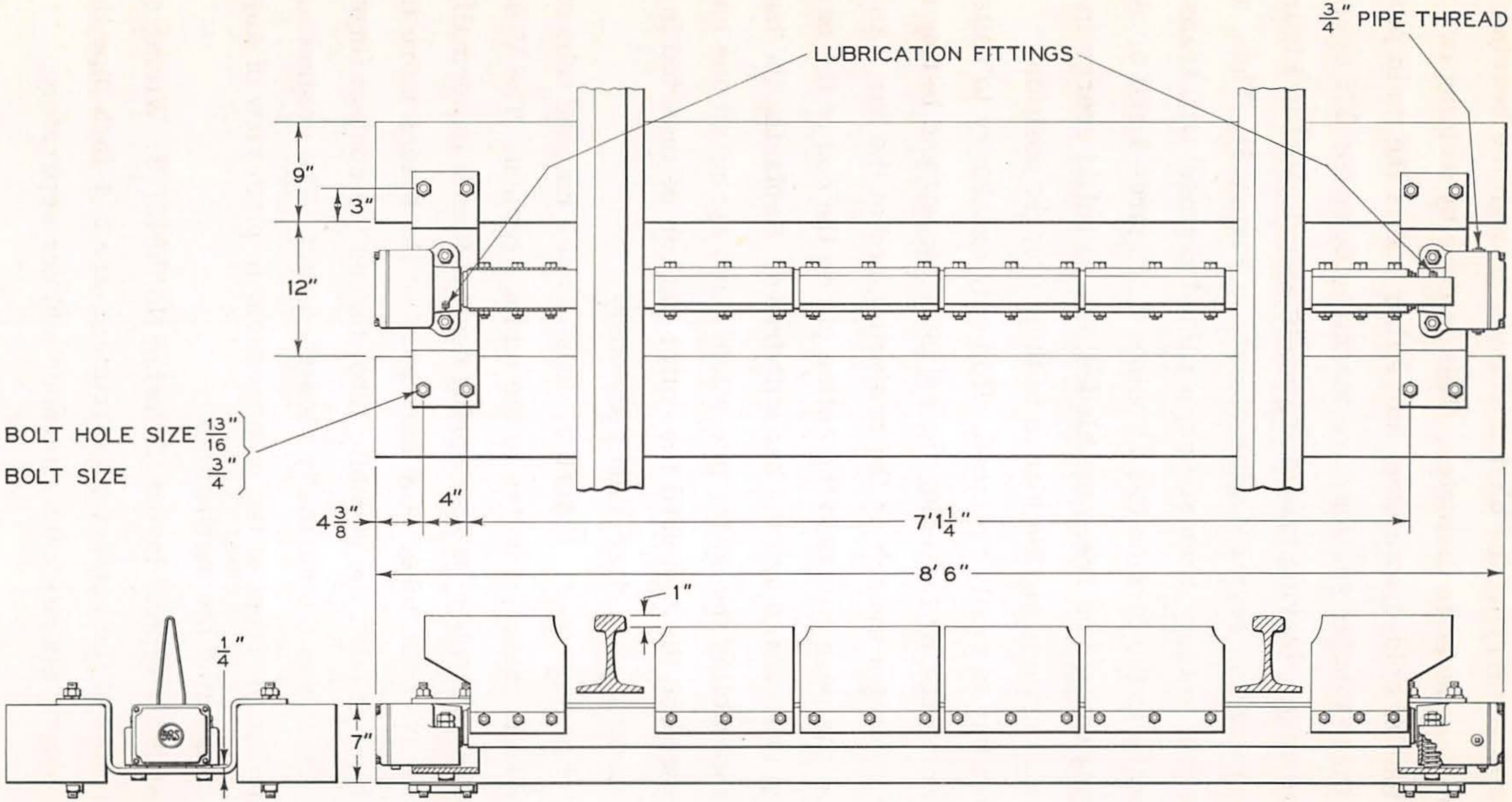

3/4" PIPE THREAD
LUBRICATION FITTINGS
9"
3"
12"
BOLT HOLE SIZE 13/16"
BOLT SIZE 3/4"
4 3/8"
4"
7'1 1/4"
8'6"
1"
1/4"
7"
GRS

Figure 6. Layout of dragging equipment detector.

ROUTE STORAGE INDICATORS FOR AUTOMATIC SWITCHING

An important feature of the G-R-S Automatic Switching System for classification yards is the ability of the system to provide route storage. The hump conductor is not limited to pushing just one button on the pushbutton machine and then waiting for the corresponding cut to clear the first switch past the hump. Instead, he may push a button as each cut is made. The system will store these routes until the corresponding cuts clear the first switch, and will then feed the stored route information through the circuits to line up the switches ahead of each cut.

The automatic switching systems installed at Markham Yard Southbound (Illinois Central), St. Luc Yard (Canadian Pacific), and John Sevier Yard (Southern), are each arranged to provide storage for four routes.* Starting with the system clear, the hump conductor can push buttons for four cuts, and the corresponding routes will be stored for use in the sequence in which the buttons were pushed. As the cuts progress over the first switch, the stored routes are transferred from storage to active development and the corresponding storage capacity again becomes available. For example, if four routes have been stored originally, and two cuts have since passed over the first switch, the hump conductor may press two buttons to bring the total number of stored routes back to four; if three cuts have passed, three buttons may be pushed, and so on.

In order to let the hump conductor know how many routes are stored, the pushbutton machines for the mentioned yards were equipped with four indicating lights. The number of these lamps lighted at any time indicates the number of routes stored, while the number unlighted indicates how many additional routes may be added. Figure 7 shows the machine for John Sevier Yard as originally built, with the four route storage lights immediately below the lever labelled HUMP SIGNAL.

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*The routes for cuts which have passed the first switch are, of course, stored in the system until each cut reaches its classification track, and in this respect the system is capable of storing as many routes as may be required by the number of cuts moving through the plant between the first switch and the classification tracks. In this article the term "storage" refers specifically to the route storage capacity for cuts which have not yet reached the first switch.

After some months of experience with these automatic switching installations, it now appears advantageous in some cases to provide more information on route storage than can be supplied by the indicating lights alone. To meet this need, a route storage indicator has been developed which shows not only how many routes are stored in the system, but also identifies the classification tracks called for by the stored routes. An indicator of this kind, now in service at John Sevier Yard, is shown in Figure 8 in position at the right-hand side of the pushbutton machine. Since they are no longer needed with the new indicator, three of the four route storage lights shown in Figure 7 have been plugged, and the remaining light converted for use as an indicator for a dragging equipment detector*.

Each of the four small panels on the face of the route indicator is backed by an opaque mask bearing transparent numerals arranged in a single left-hand column of five and a double right-hand column of 10, as shown in Figure 9. When no routes are stored in the system these numerals are invisible, and the indicator panels appear dark, as in Figure 8. But when a button is pressed, say for classification track 27, the left-

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*Comparison of Figure 8 with Figure 7 will reveal two other field changes made in this machine: (1) addition of a scale retarder control lever (upper left), transferred from its original location on the retarder operator's control panel; (2) conversion of the PIN PULLER call button (lower right) to a reset button for the dragging equipment detector. Note also the clips on buttons 20 and 24; these are to prevent the operator from pushing these buttons while the corresponding tracks are "blue-flagged", i.e., temporarily out of service. This protection on the pushbutton machine is in addition to the basic blue-flag protection which the retarder operator establishes by locking the switch levers on his panel in a position which prevents cars from entering the blue-flagged track.

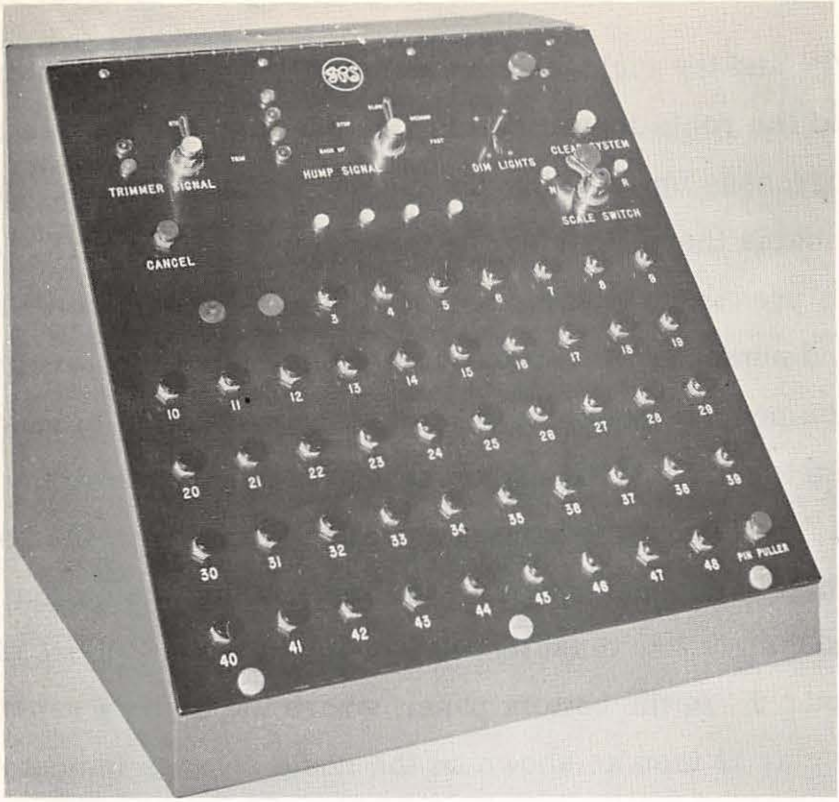

TRIMMER SIGNAL
CANCEL
HUMP SIGNAL
DIM LIGHTS
CLEAR SYSTEM
SCALE SWITCH
PIN PULLER

Figure 7. Pushbutton machine for John Sevier Yard as originally built.

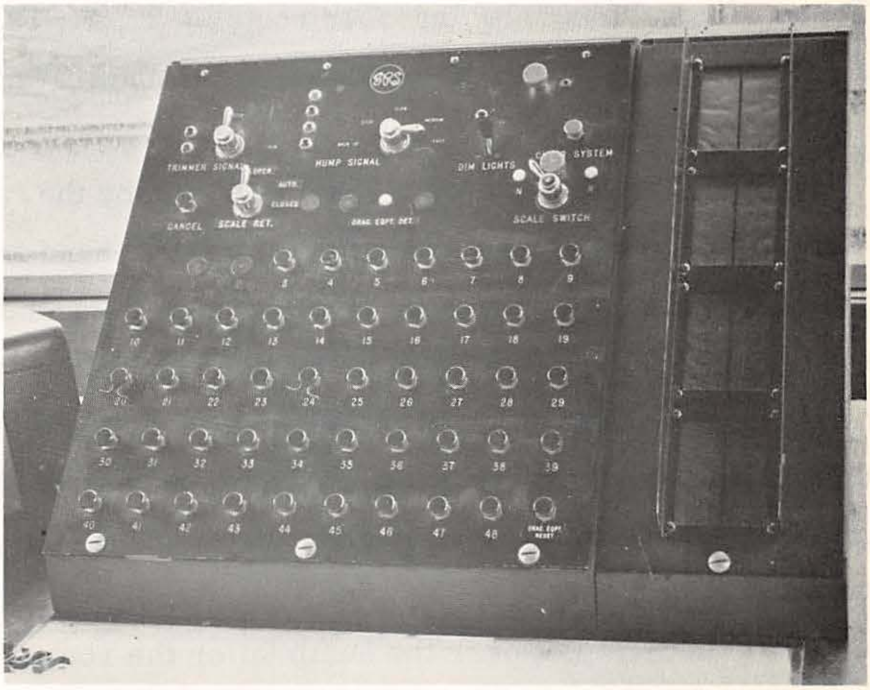

TRIMMER SIGNAL
HUMP SIGNAL
DIM LIGHTS
CLEAR SYSTEM
CANCEL
SCALE RET.
SCALE SWITCH

Figure 8. Pushbutton machine at John Sevier Yard as now in service, with auxiliary route storage indicator, and with panel modified as described in text.

hand numeral "2" and the right-hand numeral "7" are lighted in the bottom panel, and the route identification "27" is displayed. This display immediately progresses upward through the successive panels to the top panel and remains there, leaving the three lower panels dark. When the next button is pressed, say for track 41, the left-hand numeral "4" and the right-hand numeral "1" appear lighted in the bottom panel and the indication then progresses up to the panel second from top, leaving the two lower panels dark. Next, assuming button 19 is pushed, the left-hand numeral "1" and the right-hand numeral "9" appear in the bottom panel and immediately advance upward one step, leaving the bottom panel dark. Finally, pushing a fourth button, say 6, lights the left-hand "0" and the right-hand "6" in the bottom panel, where the display remains. The complete display is then as shown on the route storage indicator, Figure 10, and as repeated in column "A" of the insert in Figure 10. These illustrations show that four routes - 27, 41, 19, and 6 - have been stored in the system in the indicated order and that no further route storage is available.

Note that the display for track 6 is shown by the two-digit combination "06". This arrangement of digits, with a left-hand zero, is used for all route numbers lower than 10. If a single right-hand digit were used for such routes, failure of a lamp in the left-hand group of digits would produce misleading displays in which an incomplete two-digit number involving the faulty lamp would look like the display for a single-digit route. By using two digits for all route displays, lamp failure is immediately apparent.

When the first cut over the hump (after the routes have been stored) clears the first switch, the display in the top panel disappears, and the numbers displayed in the lower panels each advance one panel upward, leaving the bottom panel dark. Similarly, when the next cut clears the

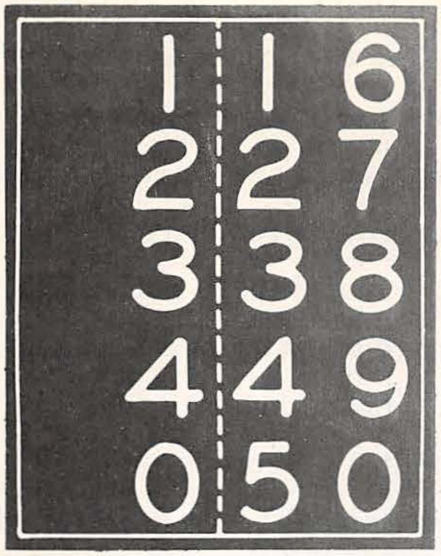


Figure 9. Arrangement of numerals on mask used with John Sevier Yard route storage indicator.

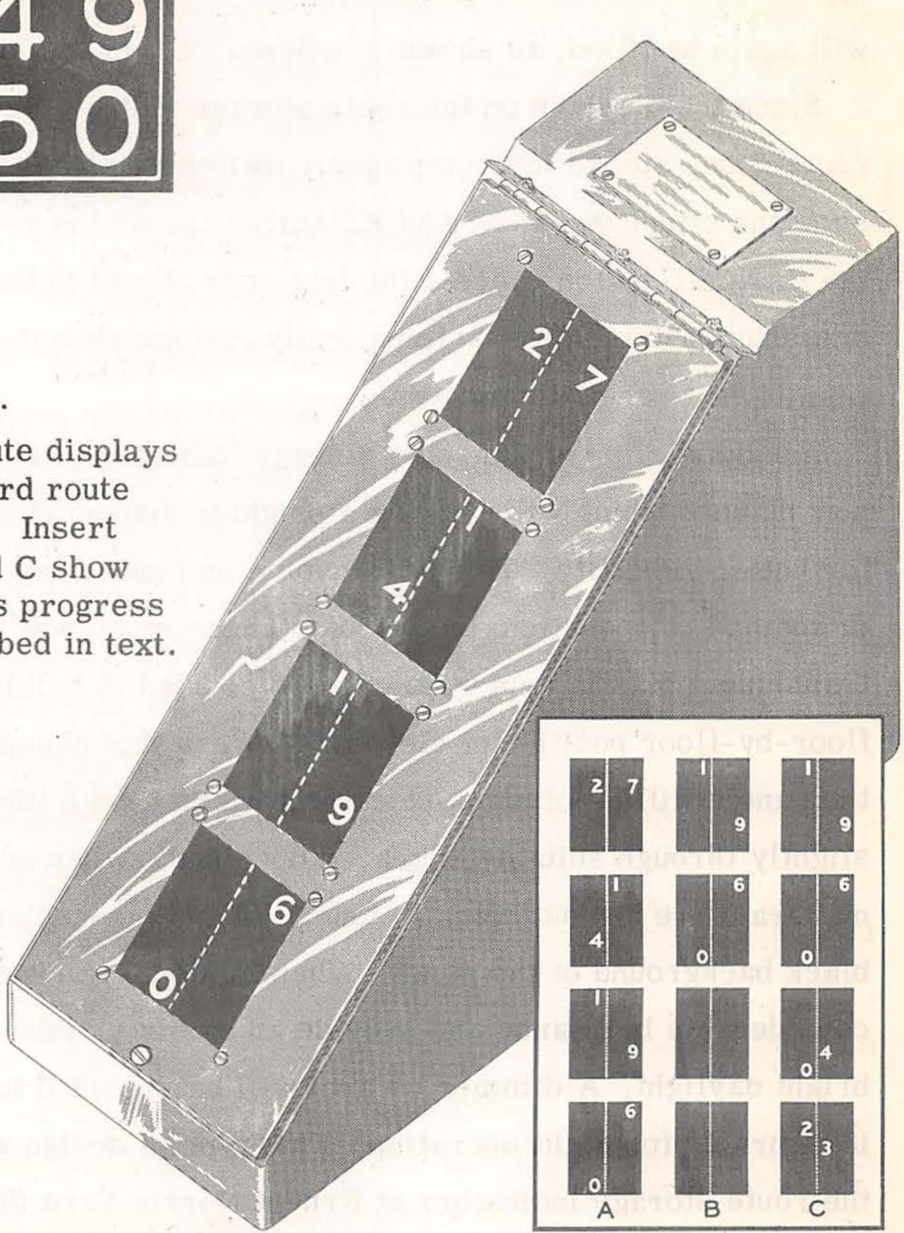


Figure 10.

Appearance of route displays on John Sevier Yard route storage indicator. Insert columns A, B, and C show how route displays progress upward, as described in text.

first switch, the indication for track 41 disappears, and the remaining indications again move up one step, leaving the two lower panels dark. The indicator then appears as shown in column "B" of the insert in Figure 10, conveying the information that routes 19 and 6 are stored for use, in that order, and that storage is now available for two additional routes. If the operator now pushes buttons 4 and 23 these routes will appear in the two lower panels and the storage capacity of the system will again be filled, as shown in column "C" of the insert in Figure 10.

Since the displays on the route storage indicator correspond to the route codes stored in the automatic switching circuits, the displays also show the effect that the CANCEL button has on the route codes. Pushing the CANCEL button cancels the last code stored in the system, hence operation of this button automatically extinguishes the last route indication (lowest panel illuminated).

A modification of the route storage indicator at John Sevier Yard is now planned which will provide a brighter display of the route numerals for better visibility. This will involve no fundamental change in circuits or method of operation, but, instead of the mask now used, will utilize translucent plastic numerals of the type used in buildings to show the floor-by-floor position of elevators. When this change has been made, the panels will be of black phenolic material, with the numerals projecting slightly through suitably engraved openings. When not illuminated, these numerals are almost black in tone, and are inconspicuous against the black background of the panel. When lighted, however, they glow with considerable brilliance and provide an easily visible display, even in bright daylight. A dimmer control will be provided to reduce intensity if desirable for night operation. This type of design will also be used for the route storage indicators at Ernest Norris Yard (Southern), Kirk Yard (E.J.&E.) and Rutherford Yard Eastbound (Reading). The indicators for the latter yards will not be in auxiliary cabinets, however, but will be built directly into the control machine panels, adjacent to the pushbuttons.

* * *

THE AMERICAN WIRE GAUGE TABLE

The American wire gauge table (same as the Browne and Sharpe table) is based on geometric progression. By memorizing a few simple rules, you can quickly learn the entire table in a form accurate enough for many purposes. When you need exact calculations, you should, of course, use the published tables.

The table is based on #10 wire, which has 1 ohm resistance per 1000 feet, is 0.1 inch diameter, and has 10,000 circular mills cross section. Once you know these characteristics of #10 wire, you can compute other sizes by use of the following rules:

1. Each consecutive ascending size number has 1-1/4 times greater resistance than its preceding size, for example, #11 has 1.25 ohms per 1000 feet.
2. Each second ascending size number has 1.6 times greater resistance, for example, #12 has 1.6 ohms per 1000 feet.
3. Each third ascending size number has 2 times greater resistance, for example, #13 has 2 ohms per 1000 feet.
4. Every tenth ascending size number has 10 times greater resistance, for example, #20 has 10 ohms per 1000 feet.

The accompanying table brings out this relationship.

Size	Resistance			Size	Resistance			Size	Resistance			Size	Resistance		
				0	0.1			10	1			20	10		
				1		0.125		11		1.25		21		12.5	
				2			0.16	12			1.6	22			16
				3	0.2			13	2			23	20		
				4		0.25		14		2.5		24		25	
				5			0.32	15			3.2	25			32
				6	0.4			16	4			26	40		
0000		.05		7		0.50		17		5		27		50	
000			.064	8			0.64	18			6.4	28			64
00	.08			9	0.8			19	8			29	80		
Size	Resistance			Size	Resistance			Size	Resistance			Size	Resistance		
30	100			40	1000			50	10,000			60	100,000		
31		125		41		1250		51		12,500					
32			160	42			1600	52			16,000				
33	200			43	2000			53	20,000						
34		250		44		2500		54		25,000					
35			320	45			3200	55			32,000				
36	400			46	4000			56	40,000						
37		500		47		5000		57		50,000					
38			640	48			6400	58			64,000				
39	800			49	8000			59	80,000						

Size-resistance relationships of A.W.G.

The area in circular mills also follows this pattern, but in reverse order - the area in circular mills increases as the size number decreases. The diameter of #10 is 0.1 inch, and the progression is as follows:

1. Each consecutive descending size number has 1.12 times greater diameter than its succeeding size, for example, #9 has a diameter of 0.112 inch.
2. Every second descending size has 1.25 times greater diameter.
3. " third " " " 1.4 " " "
4. " fourth " " " 1.6 " " "
5. " fifth " " " 1.8 " " "
6. " sixth " " " 2.0 " " "
7. " twentieth " " " 10.0 " " "

When considering copperweld wire, the equivalent size of copper wire can be obtained by adding four numbers to the copperweld for 40 percent conductivity, five numbers for 30 percent conductivity. For 80 percent conductivity, (phono-electric), add one number.

GENERAL RAILWAY SIGNAL COMPANY

G-R-S NEWS
July 1951

NOTE: The following article gives you advanced sales engineering information which should not be discussed with railroad personnel (except for a good reason) as the system has not as yet been commercialized.

*   *   *

G-R-S AUTOMATIC TRAIN CONTROL SYSTEM

Selective-Frequency Auto-Manual Type

General

The G-R-S Automatic Train Control System, Selective-Frequency Auto-Manual Type, is designed to check an engineman's alertness to the aspects of wayside signals by compelling him to operate an acknowledging contactor whenever he passes a restrictive (caution or stop) signal. Failure to acknowledge produces an automatic brake application which cannot be released until certain conditions, (complete stop, time lapse, or pre-established low speed) have been met. The acknowledging circuits are arranged so that actuation of the contactor for a period exceeding 15 seconds also produces an automatic brake application; it is not possible to circumvent the system by blocking the contactor in the "acknowledge" position.

This type of control is similar to that supplied by the G-R-S intermittent inductive train control system which has been widely used for over 25 years. It utilizes the same general idea of locating at each wayside signal an inductor which produces a reaction in the locomotive equipment when the signal is restrictive, but which has no effect when the signal is clear. The method of accomplishing this in the new system is, however, quite different from that used by the older intermittent system. In particular, the selective-frequency system does not use magnetic structures in the inductors and receivers, with the result that the equipment is not affected by stray magnetic fields, and so may be applied to operations in electrified zones (both overhead and third-rail) as well as to non-electrified operations.

Figure 1 illustrates the general organization of a selective-frequency train control system as applied to an electric locomotive. This illustration is intended only to give an idea of general arrangement; actual installations would be designed to meet specific operating requirements, and to mount in available space.

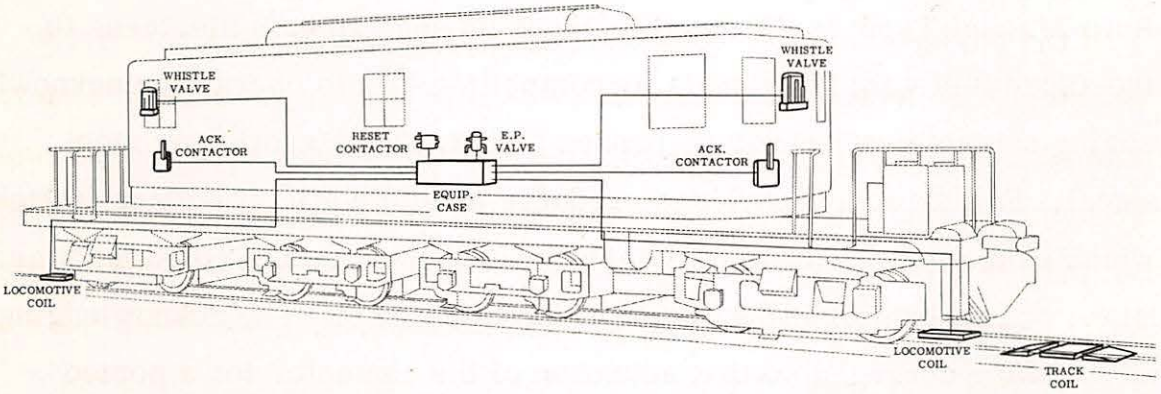


Figure 1. Organization of system.

Operation

The electro-pneumatic valve shown in Figure 1 is an electrically controlled valve in the brake system which, when deenergized, initiates a brake application. As long as the locomotive receiver is moving over the track between signals, or is passing over inductors at clear signals, the mechanism in the equipment case holds the electro-pneumatic valve energized, and the train brakes remain under the control of the engineman.

When the receiver passes over an inductor at a restrictive signal, however, an interaction occurs between the inductor and locomotive receiver which causes a primary relay in the mechanism to drop away. Unless the engineman is holding the acknowledging contactor in the "acknowledge" position when this occurs, dropaway of the primary relay causes deenergization of the electro-pneumatic valve, producing a brake application which cannot be released by the engineman until the system has been reset. In the arrangement shown in Figure 1 he can reset only by leaving his accustomed operating position and operating the reset contactor; other arrangements are available in which the reset contactor is located at the engineman's operating position, but is ineffective until the automatic brake application has reduced train speed below a pre-set value or until a specified time has elapsed after the occurrence of the automatic brake application.

If the engineman acknowledges properly when passing a restrictive inductor, the electro-pneumatic valve is held energized, and the engineman retains full control of the braking system. Under these conditions the primary relay drops away momentarily as the receiver passes over the inductor, but is picked up again immediately thereafter, holding the electro-pneumatic valve energized after the engineman releases the acknowledging contactor. Dropaway of the primary relay actuates the whistle value, regardless of acknowledgment, so that a short whistle blast occurs each time a restrictive inductor is passed, giving the engineman an audible check that the system is responding properly to the restrictive condition.

Transmission of Control

Figure 2 shows in diagrammatic form the operating principles involved in transmission of control from the wayside to the locomotive.

Included in the locomotive equipment is a crystal-controlled vacuum-tube oscillator and associated circuits, represented by the blocks labelled Oscillator, Buffer, and 100 kc. Crystal. While the locomotive is proceeding between wayside signals, and also when it is passing over inductors at clear signals, this oscillator functions continuously, generating 100-kc. a.c. which, after amplification by the Power Amplifier, is fed through the Coupling Transformer and Rectifier to produce d.c. for energizing Primary Relay R1. As we have seen above, R1 energized holds the electro-pneumatic valve energized, and control of the brakes remains with the engineman.

The receiver coil is part of a circuit tuned to 100 kc. from which feedback is taken, through the 100-kc. crystal, to maintain oscillation. If this receiver coil circuit is detuned, the feedback is reduced below the value necessary to sustain oscillation, and the oscillator stops. When the oscillator stops, R1 must drop away, since R1 is energized by the rectified a-c. output of the oscillator and is completely isolated from the d-c. circuits feeding the vacuum tubes by the coupling transformer.

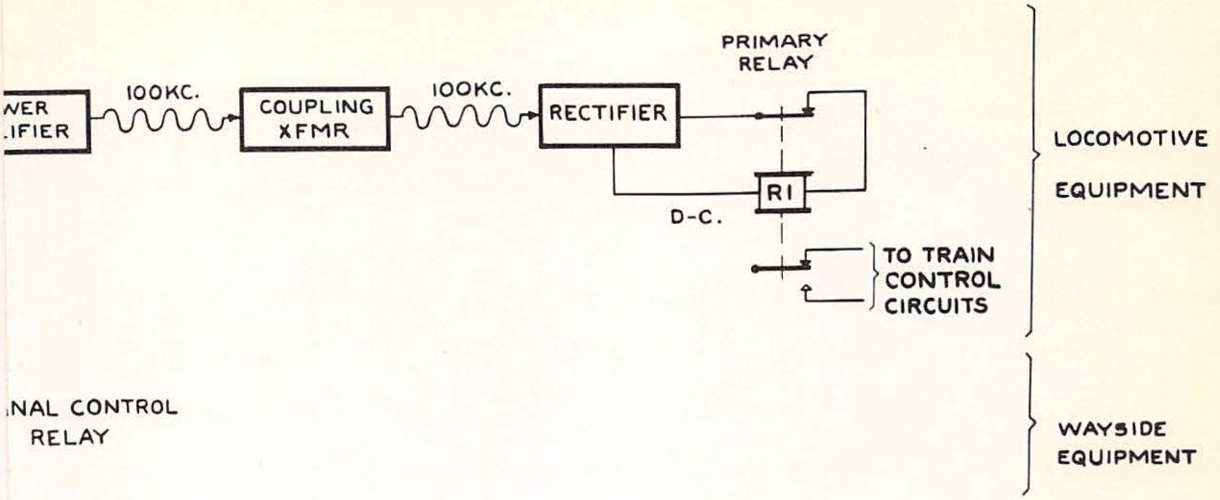
The block labelled Inductor in Figure 2 represents the device which transmits restrictive controls to the locomotive receiver. In practice, this is a weatherproof unit, mounted between the rails as shown in Figures 4 and 5, and provided with suitable protection against damage from dragging equipment, falling objects, etc. The electrical theory of the action of the inductor upon the locomotive receiver is beyond the scope of this article, but the general principle is easily understood. Briefly stated, operation depends on the fact that a non-energized resonant circuit tuned to a specified frequency can, by inductive coupling, detune an energized circuit normally resonant at the same frequency. This principle is applied in the train control system by arranging the inductor and its control circuits so that the inductor is a tuned 100-kc. circuit when the associated signal is restrictive, but is non-resonant when the signal is clear. As a result of this arrangement, any passing locomotive receiver circuit is detuned by inductive coupling when the signal is restrictive, but is unaffected when the signal is clear. As we have already seen, detuning of the receiver circuit causes the locomotive primary relay to drop away, and the desired control is achieved. With receiver and inductor coils of the size used in this system, the reaction between the coils is sufficient to produce complete quenching of the oscillator with a vertical center-to-center distance between the coils as great as 17 inches.

The inductor includes two coils. One of these, the upper coil as symbolized in the Inductor block of Figure 2, is self-resonant at 100 kc. That is, the coil is so proportioned and wound that the distributed capacitance between turns is the proper value to resonate the winding at 100 kc. without the use of a separate condenser. The lower inductor coil is closely coupled to the upper coil, and acts as the secondary of an air-core transformer, with the upper coil as primary. When the external leads from the lower coil are shunted by the contact on the signal control relay (clear signal) an equivalent short circuit is reflected by transformer action across the upper coil, destroying its resonance characteristic. When the external leads from the lower coil are open-circuited (signal control relay down, restrictive signal), there is no effect on the upper coil, and the latter retains its 100-kc. resonance characteristic. The inductor is therefore non-resonant when the signal is clear, and resonant for all restrictive conditions. It is also resonant if circuit failure opens the electrical connection between the inductor secondary coil and the signal control relay; i.e., line breakage between the inductor and the control relay places the inductor in the same condition as a restrictive signal. As mentioned previously, the resonant or non-resonant condition of the upper inductor coil is the factor which determines the effect that the inductor has on the locomotive equipment. Note that this effect is achieved without requiring any energy supply to the inductor, and by simple opening or closing of a single contact.

The foregoing description of the transmission of control is summarized pictorially in the two parts of Figure 2. Figure 2a shows the condition when the locomotive receiver passes over an inductor at a clear signal. Note that the signal control relay is energized, short-circuiting the inductor secondary winding, and destroying the inductor resonance characteristic. As a result, the locomotive oscillator continues operation, a.c. is fed to the coupling transformer and rectifier, and R1 is held up by the resultant d-c. output.

Figure 2b shows the condition when the locomotive receiver passes over an inductor at a restrictive signal. Now the signal control relay is deenergized, and the inductor is resonant, detuning the receiver circuit and quenching the oscillator. As a result, R1 has dropped away.

An important feature of the oscillator-buffer circuits which should be noted here is that they incorporate special features which produce cutoff of a-c. output to the power amplifier the moment the oscillator output begins to fall off under the influence of the inductor. The system does not wait for the oscillator to be completely quenched before energy is removed from the primary relay; the relay is actually deenergized instantaneously with the entry of the locomotive receiver coil into the zone of influence of the inductor. This rapid cutoff of energy, in conjunction with the use of a very fast-acting primary relay, enables the system to operate reliably at train speeds in excess of one-hundred miles an hour. Moreover, since the interaction of the inductor and receiver circuits is entirely a matter of the inductive coupling of a.c. in the receiver coil into the inductor coil, operation does not depend upon the relative passing speed of the coils, and control is effective down to zero miles per hour.


WER
IFIER
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COUPLING
XFMR
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RECTIFIER
PRIMARY
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R1
D-C.
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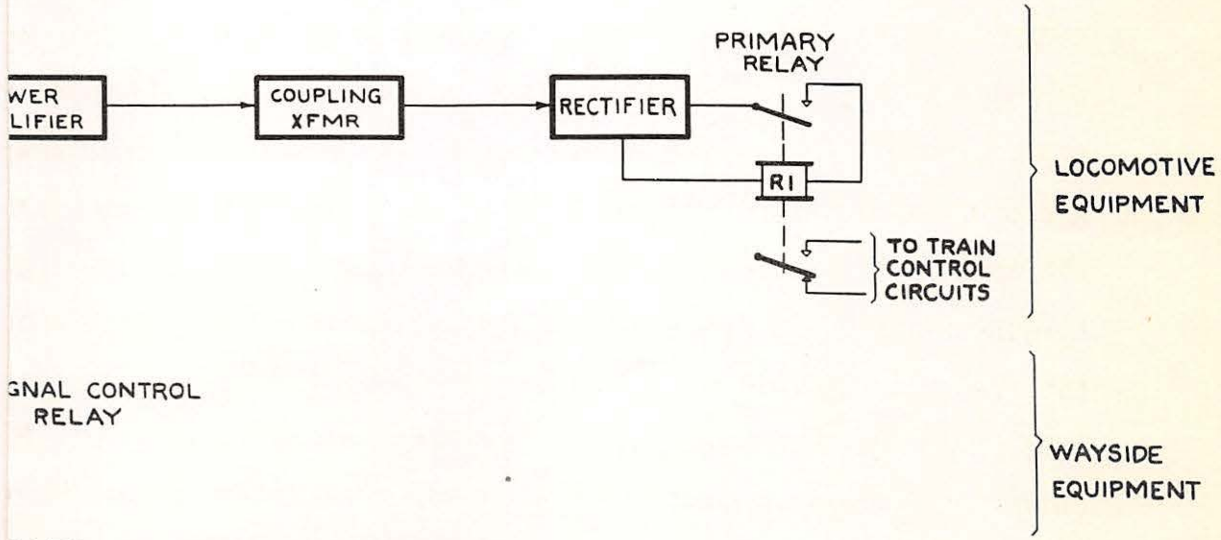
RELAY
WAYSIDE
EQUIPMENT

VER INDUCTOR, CLEAR SIGNAL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RECTIFIER
PRIMARY
RELAY
R1
TO TRAIN
CONTROL
CIRCUITS
LOCOMOTIVE
EQUIPMENT
GNAL CONTROL
RELAY
WAYSIDE
EQUIPMENT

OVER INDUCTOR, RESTRICTIVE SIGNAL

Figure 2. Circuit organization, transmission of control from wayside to locomotive equipment.

Adaptability to Speed-Control System

By adding a 150-kc. oscillator and receiver coil, a governor, and appropriate auxiliary equipment to the 100-kc. locomotive system described above, and a 150-kc. inductor at each wayside signal, the selective-frequency principle can be used as the basis for an intermittent three-speed speed-control system. In such a system, controls for the various speeds are obtained by using appropriate combinations of the restrictive and clear conditions of the two inductors to control the two oscillators as required. Four-speed control may be similarly obtained by use of a three-receiver, two-inductor arrangement.

Features of System

1. System is applicable to all types of motive power, including electric locomotives. Not affected by electric transients and stray magnetic fields.
2. Positive operation at all speeds from 0 to over 100 miles per hour.
3. Receiver-inductor clearances are large, and tolerances are not critical. Inductors are located between rails with upper surface approximately two inches below rail head. Receivers are mounted on locomotive so as to move along track center line, approximately eight inches above rail heads. Nominal receiver-inductor clearance is ten inches; variations of plus and minus two inches from this clearance do not affect operation of system. Inductors may be located on the track center line as shown in Figures 4 and 5, or may be located to one side or other of center line with similar arrangement of locomotive receivers, to provide directional selection of control for two-direction operation on same track.

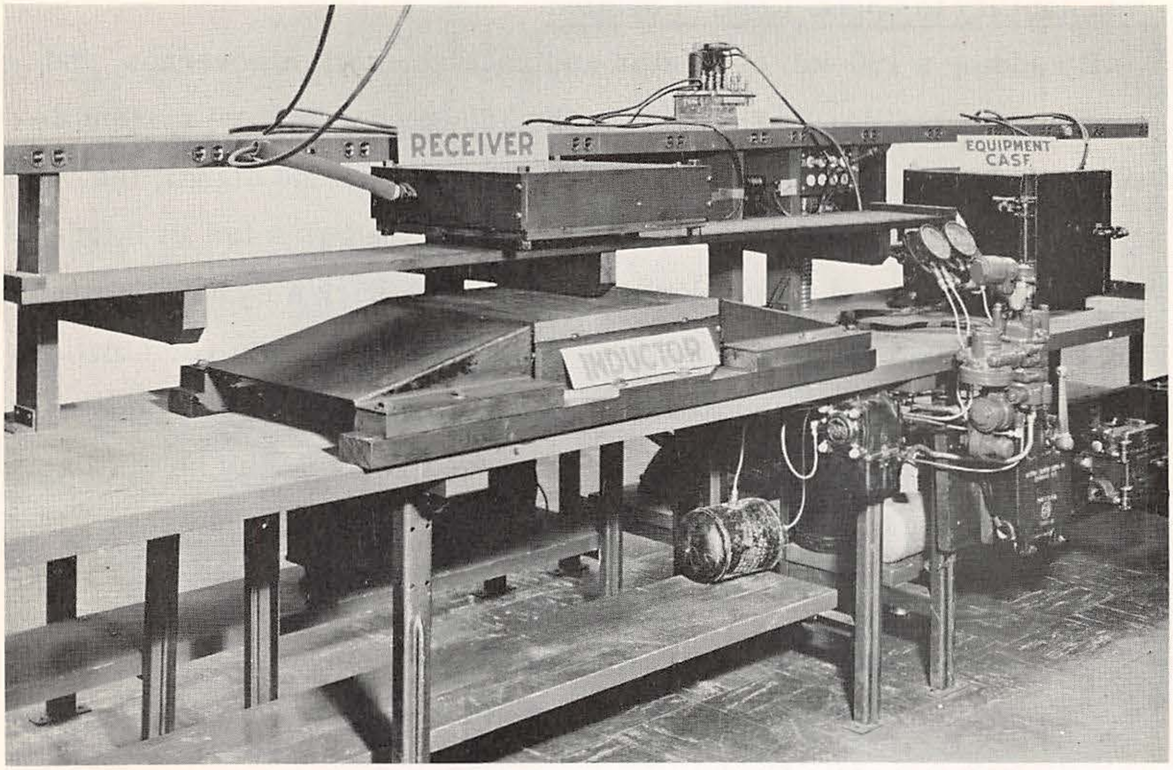

RECEIVER
EQUIPMENT CASE
INDUCTOR

Figure 3. Laboratory set-up demonstrating transmission of controls.

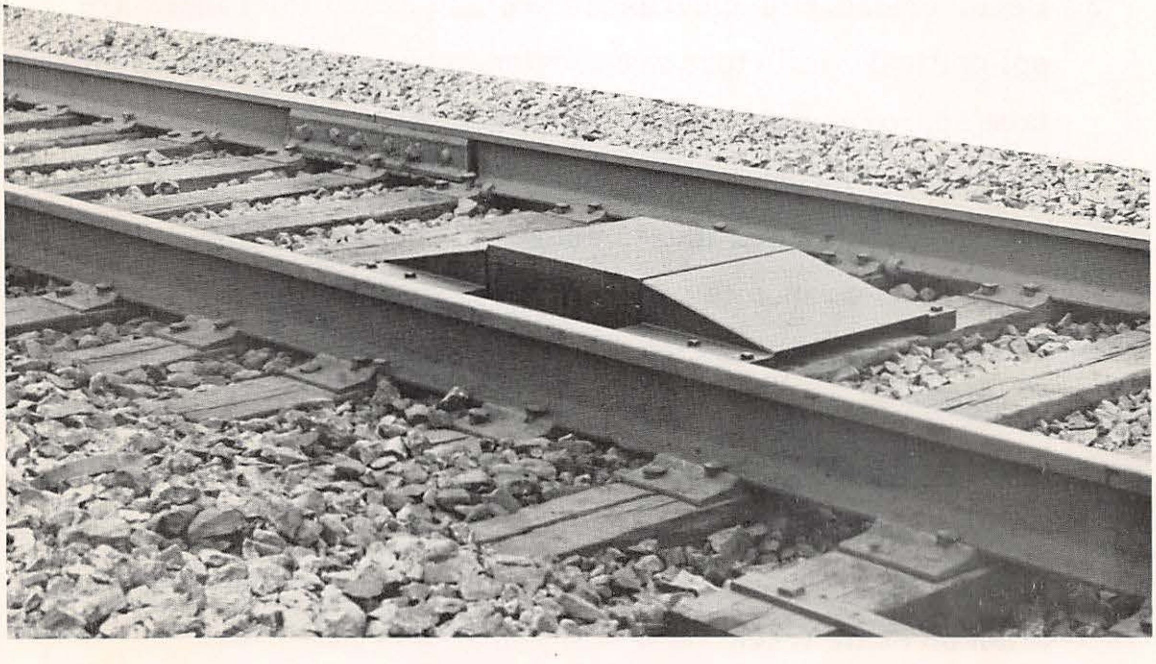


Figure 4. Inductor for G-R-S selective-frequency train control system.

4. Receiver unit uses rugged coil made up of comparatively few turns of heavy (#12 stranded) wire, hermetically sealed in rubber. Connection to mechanism is through armored, corrosion resistant coaxial cable.
5. Inductor unit uses rugged coils of comparatively few turns of heavy (#12 stranded) wire, hermetically sealed in rubber.
6. Inductor coil is self-resonant; no condenser is used.
7. Inductor coil is completely isolated from direct electrical connection with external circuits, and is controlled through a separate secondary winding vulcanized in same jacket.

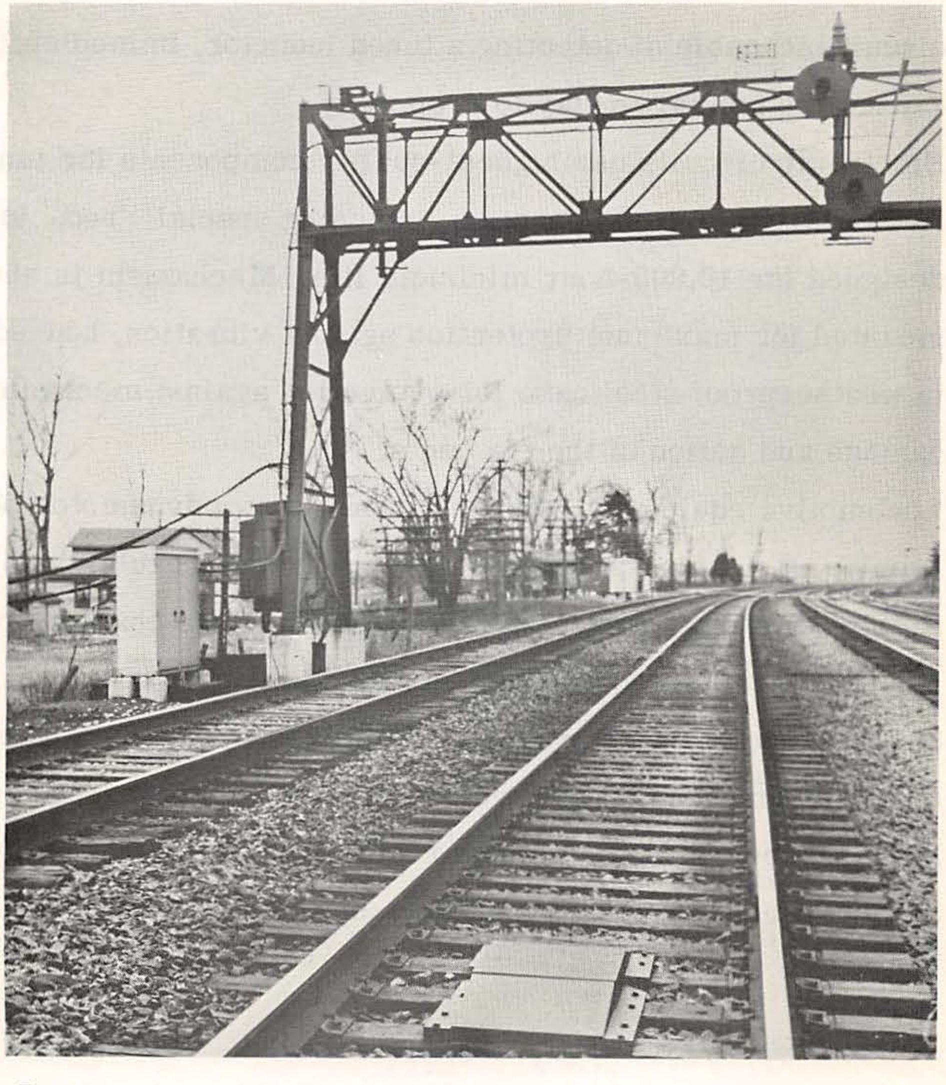


Figure 5. Location of inductor with respect to wayside signal.

8. Inductor control requires no energy. Clear condition is obtained by simple shunt on a pair of leads, restrictive condition by removing shunt. If connection to control circuit opens, inductor is automatically in restrictive condition.
9. The oscillator unit employs a fail-safe circuit in which every element in the circuit must be intact and functioning properly to maintain the holding current in the primary relay. The crystal, the receiver and its cable, the tuned elements in the circuit, all provide a mutual check on each other such that a failure in any one of these elements, which would render the circuit incapable of detecting a tuned inductor, immediately causes the primary relay to drop away.
10. Electronic circuits use highest-quality components for long life and trouble-free operation, including special "red" tubes designed for 10,000-hour minimum life. Mechanism is shock-mounted for maximum protection against vibration, housed in weatherproof steel case for protection against mechanical damage and action of the elements.
11. Locomotive equipment operates from its own dynamotor power supply; all control circuits are isolated from regular locomotive supply. System is insensitive to supply voltage changes; power input requirement for system is approximately 100 watts.
12. Maintenance requirements are minimized by sturdy design of equipment, non-critical receiver-inductor clearance. Maintenance work that may be required is facilitated by use of plug-connected relays and electronic unit.

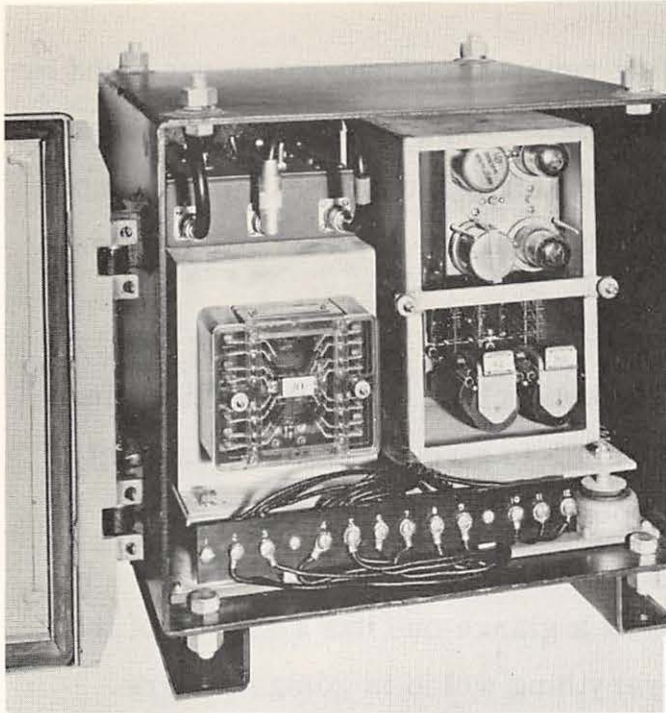


Figure 6. Locomotive mechanism in equipment case.

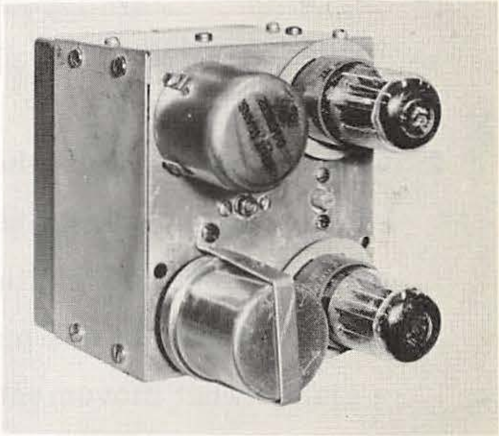


Figure 7.

Plug connected oscillator-amplifier unit.

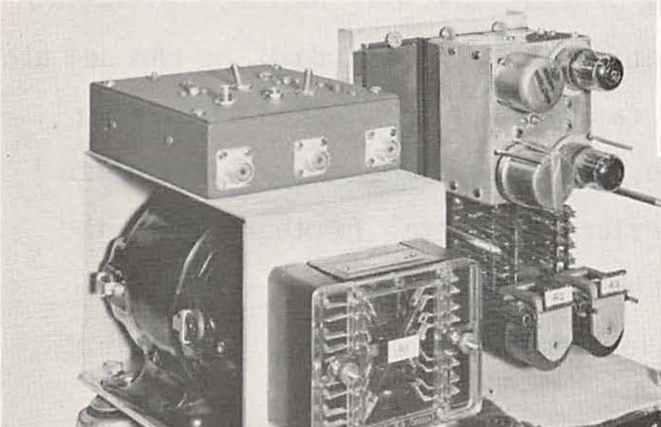


Figure 8. Locomotive mechanism removed from equipment case showing dynamotor.

NX through Other Eyes

The following is an interesting report on NX operation prepared by Mr. J. H. Verstegen, Chief of the Signal Department, the Netherlands Railways, and directed to Professor Carlo Jachino of S. A. Scipione Innocenti Bologna (SASIB) under date of April 30, 1951. We quote.

* * *

The NX installation at 'sHertogenbosch has been in service since September 1950, so it is now possible to give my opinion, and that of the Traffic Department, on the operation of this station.

The outstanding facts are:

1. The great surveyability. At a glance one has a survey of the whole track layout and everything which is going on there. This results in:
2. Quick control. Since the whole operation takes place from one spot on a very small and concentrated surveyable control machine, the entire handling of train, and marshalling movements is in the hands of one man; he is 100% in control, he can see at a glance what movement can be made in time before another movement can take place, and, if by chance some movements take too long, he can interfere, etc., etc. In other words, the capacity of a station can be fully utilized.
3. Very quick operation. This requires only seconds instead of minutes.
4. Switches released sooner. The fact that the switches become free for operation, immediately after a train passed, is a very great advantage. In consequence of this, the question has arisen whether it would be possible to install such arrangements everywhere.

5. During fog, snow and frost everything is under better control. From the one spot, one has a better chance to test operation of the switches, and can immediately direct a man to the threatened point.

   With regard to the operation of the whole installation, fog has no influence at all; even when the weather is bright, it often happens that the operator does not glance through the window for hours and therefore does not make any use of the direct view.

6. First experience. It is, of course, necessary that the people inside and outside the control room cooperate with each other, preferably by a complete planning of all marshalling - and train movements.

   As an example, in the beginning more than 20 telephone conversations were necessary every five minutes, now after some time of experience only a few telephone conversations are held. Only then can the full capacity of the NX installation be realized.

   It is of great importance to keep the mere humping and fly shunting of cars outside the NX area, and only protect the NX area against movements of these marshalling operations.

7. Indispensability. As soon as the personnel is completely accustomed to the operation of the NX system, only one expression is heard: we could not do without this installation.

8. All movements completely protected. Not only all train movements but also all shunt movements in the NX area are completely protected. Economies in personnel can be obtained as the shunting operations need not be specially supervised.

9. Economizing by concentration. By concentration in one spot, 7 men of personnel could be released. It was expected that two

men would be necessary to operate the control machine, but after training and becoming experienced a second man is put in only in the peak hours.

10. Cost and saving. The saving of costs, besides the enormous traffic and technical advantages, easily equals or exceeds the greater expense of an NX installation. Indeed, in the case of modern requirements for a normal electric-interlocking, including paragraph 11, the costs of an NX installation are not higher.

11. Complete track circuit protection. This is inherent in an NX Installation, and is of such value in an important signaling installation, that it hardly can be omitted.

12. Difficulties. In this point I arrive at the only important difficulty, which we experienced with the insulations for the 80 track circuits. A few failures, caused by these insulations, occurred and were found to be very inconvenient; the traffic department has already asked for emergency knobs to release the track locked switches. It is, however, my intention to do everything to rectify the evil; the insulation material for the insulating connections proved to be not very good. I wish to change this for high class material and then see the results, in order to decide whether it will be necessary to install the above mentioned emergency knobs.

If at all possible, I wish to avoid these emergency knobs, because, the advantage of the great safety obtained by using a completely track circuited layout, would be partly lost with the emergency knobs, although they are sealed.

In conclusion, I can say that we are very satisfied with this system, and we are at work with other stations.

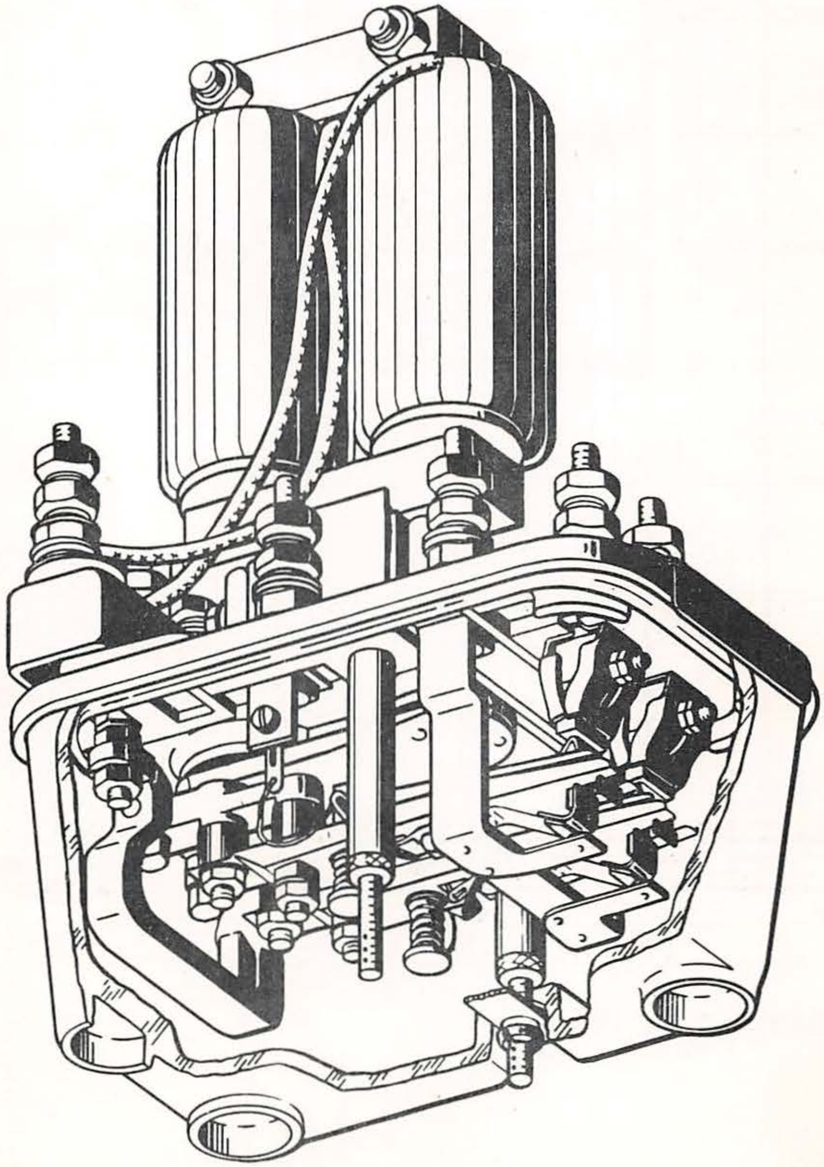
GENERAL RAILWAY SIGNAL CO.

G-R-S NEWS
June 1951

NEW CORE DESIGN

To provide for easier assembly we are now furnishing Type K2 biased neutral relays with straight cores and yokes, as shown in the drawing below. The leakage strip below the coils prevents the relay from picking up if the yoke strap is removed when the relay is in service.

This design is also contemplated for K4, K6, and K8 biased neutral relays.



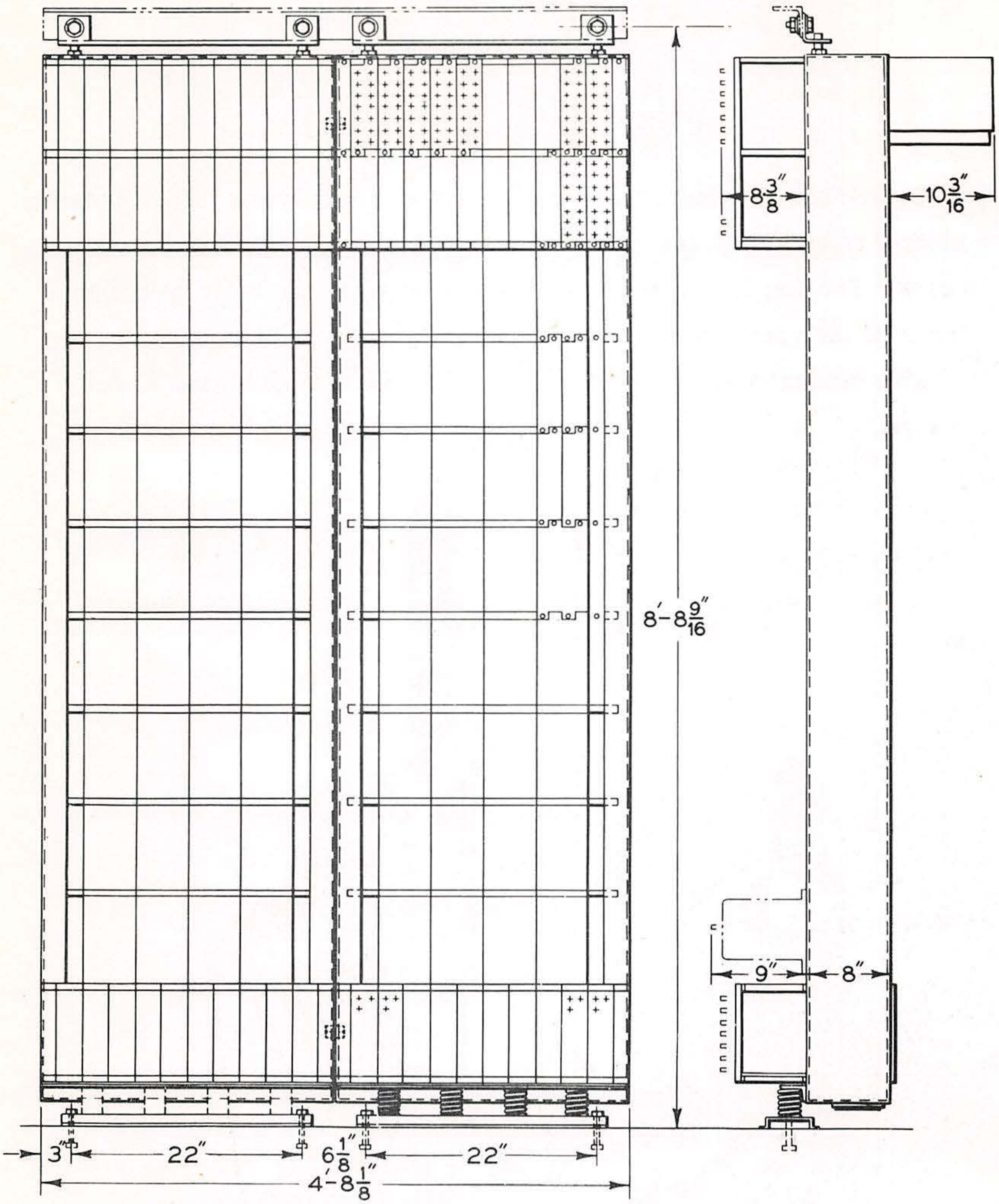

8 3/8″
10 3/16″
8′-8 9/16″
9″
8″
3″
22″
6 1/8″
22″
4′-8 1/8″

Figure 1. New B relay rack.

NEW B RELAY RACK

A neater appearing B relay tower rack, 31917-8, has been designed, Figure 1, with 8-inch side channels made of formed sheet steel. With this increase in side channel width, and with the plugboard mounting bars now bolted to the front of the channels, there is ample room within the channel for wiring and cables. The new rack is lighter and of ample strength and rigidity.

The rack is wider, measuring 2 feet 4 inches, and will accommodate Type A relay cabinets between the upright channels on the conventional mounting hooks.

The terminal boards, Figure 2, are now the width of a B1 plugboard. Wire eyelets can be attached before the wires are brought through the slots in the board for connection. This facilitates wiring methods.

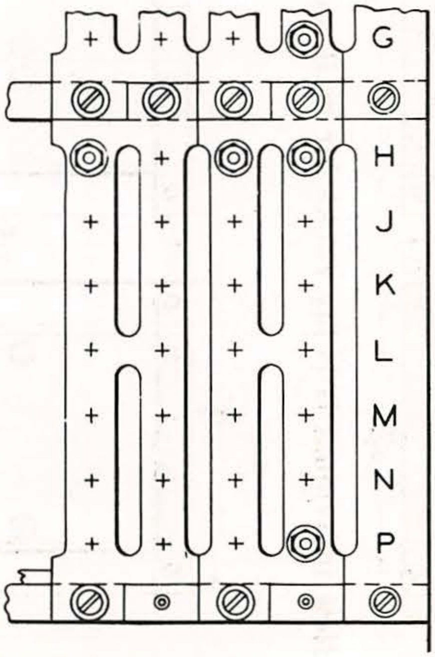


Figure 2. New terminal boards.

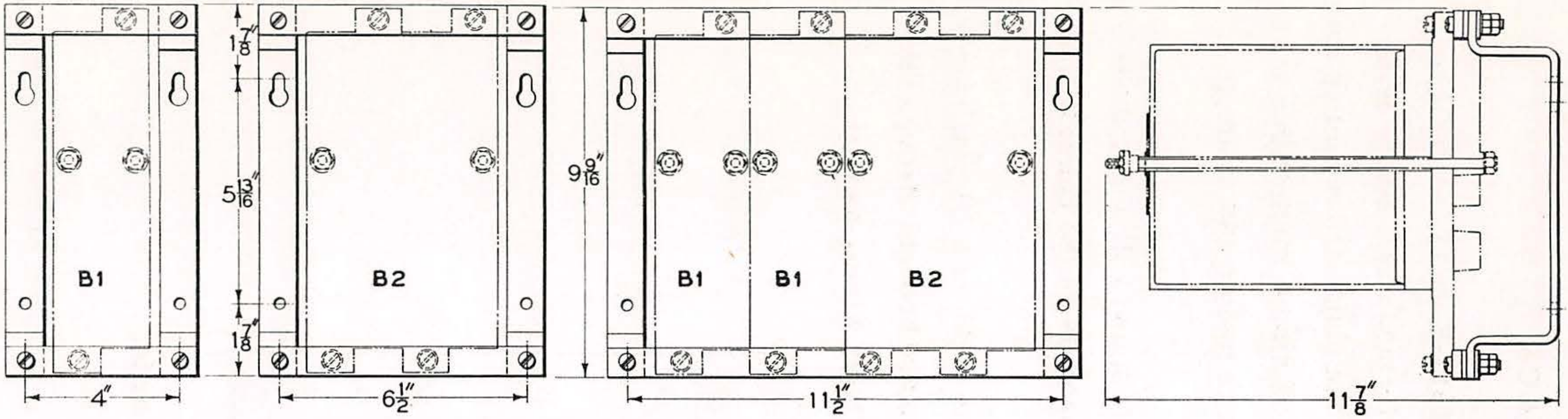

1$\frac{7}{8}$"
5$\frac{13}{16}$"
1$\frac{7}{8}$"
B1
4"
B2
6$\frac{1}{2}$"
9$\frac{9}{16}$"
B1
B1
B2
11$\frac{1}{2}$"
11$\frac{7}{8}$"

Figure 3. New individual B relay racks for wall mounting.

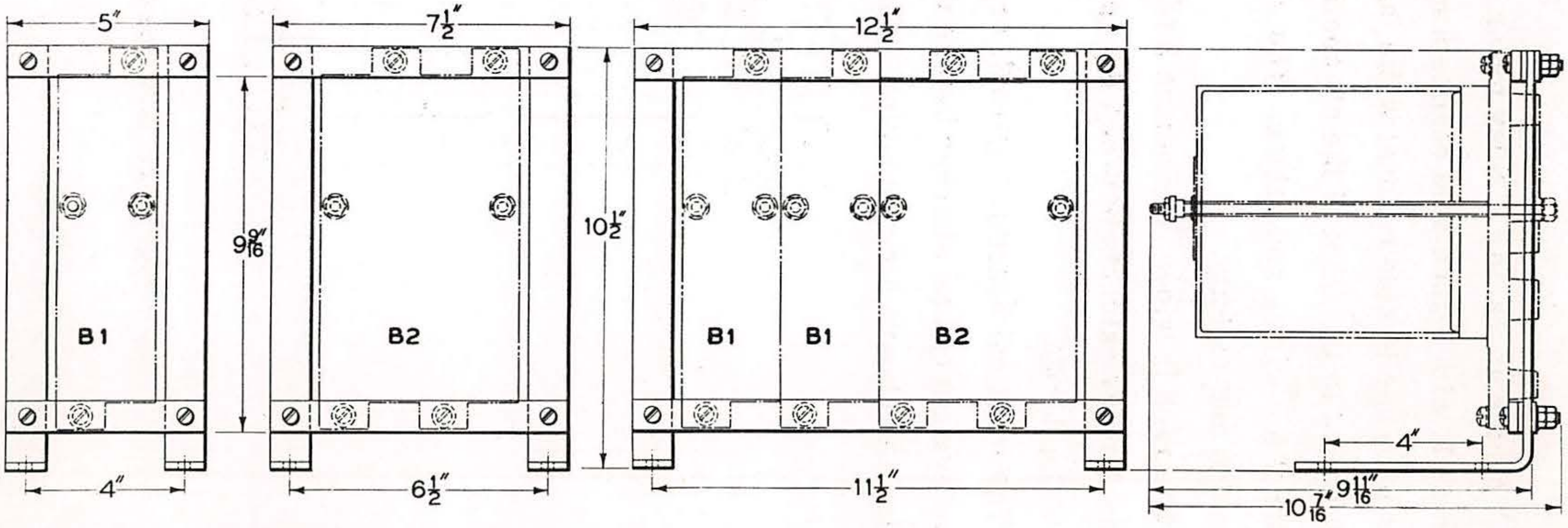

5"
7$\frac{1}{2}$"
12$\frac{1}{2}$"
B1
4"
9$\frac{9}{16}$"
B2
6$\frac{1}{2}$"
10$\frac{1}{2}$"
B1
B1
B2
11$\frac{1}{2}$"
4"
9$\frac{11}{16}$"
10$\frac{7}{16}$"

Figure 4. New individual B relay racks for shelf mounting.

will bring the voltage up to 10.4. Now, when the remaining original cells are depleted, voltage will be around 8.8 instead of 8 volts as it would be if you had left all the original cells in the battery. Thus this system narrows the range of voltage variation to only 1.6 volts as compared to 3.2 volts.

This range of voltage variation can be made even narrower by changing out 4, 2, or even 1 cell at correspondingly shorter intervals.

The accompanying graph shows these variations. The voltage variations for each procedure; changing out 8, 4, 2, or 1 cell at a time; are shown at the right of the graph.

Note that line A, representing 16 cells left in service till exhaustion, goes down from 11.2 volts with new cells to 8 volts with cell life 100 percent consumed. At 50 percent life, line A shows 8.8 volts. Line B, representing results of renewing 8 cells at a time, intersects line A at 8.8 volts and rises to 10.4 volts, showing that the 8-cell renewal system would give you a voltage of 10.4 volts when you renewed the 8 cells. Thus the voltage variation with the 8-cell renewal system would be between a high of 10.4 and a low of 8.8 volts, a range of 1.6 volts or 18.1 percent variation. Note that this variation does not take into account the original 11.2-volt level. Variation for lines C, D, and E, renewing 4, 2, or 1 cell at a time, are based on the same premise. The 0.2-volt variation for line E, for example, assumes that you have completed a cycle of renewals on this 1-cell basis.

The advantages of this system of staggering cell renewals is that you are maintaining a more constant voltage level. The smaller the variation in voltage the less energy is wasted. In addition, by never allowing the battery to approach too closely to the fully exhausted voltage level, you are assured of more dependable operation.

Of course, this system of renewal entails more work for the maintenance force. Increased labor costs involved may even offset the benefit. However, it may be possible to fit this activity into existing work schedules without increasing labor costs.

One word of caution: this method works only for series-connected cells. It will not work for cells in multiple, as the new cell will assume the load until its voltage drops to the level of the old cell; and then they will become exhausted at the same time.

For additional information on getting your money's worth out of primary cells, see:

Railway Signaling, September 1935, pp. 463-468, "Primary Battery Costs Being Reduced on the Sante Fe."

Railway Signaling, July 1934, pp. 351-352, "Operating Costs of A-C. Primary System of Power Supply."

* * *

GENERAL RAILWAY SIGNAL COMPANY

G-R-S NEWS
May 1951

G-R-S CROSSING GATE MECHANISM

While the Type B crossing gate mechanism is not a new device (it was announced to the railway world in September 1949), we are asked by our sales force occasionally for data in some brief form such as G-R-S NEWS.

Description

The accompanying illustrations, Figures 1 and 2 show that the mechanism and gate arm shaft are in a single housing which can be clamped to a 5-inch mast, generally so the shaft is about 4 feet 10 inches above the crown of the street.

The mechanism is designed for low voltage d-c. operation, to raise the gate arm from the horizontal to the vertical position by means of the motor and gear train, and to hold it vertical by means of a ratchet and pawl while the hold-clear magnet is energized.

When the hold-clear is deenergized, the gate arm lowers by gravity, assisted by power from 90° to 45°, and retarded by dynamic braking from 45° to 0° (horizontal).

A slight change in the mechanism wiring will convert from power-down to gravity return only. These circuits are shown in Figure 14.

The main shaft, 2 inches in diameter, is supported in ball bearings and is splined to receive the main driving gear sector and gate arm supports. The sector comes in contact with two stops, Figure 9, at the 0° and 90° position.

If a sidewalk arm is used, the mechanism is supplied with an additional shaft which has a square section extension on one side only of the mechanism case. See Figure 1. This shaft can be easily changed from one

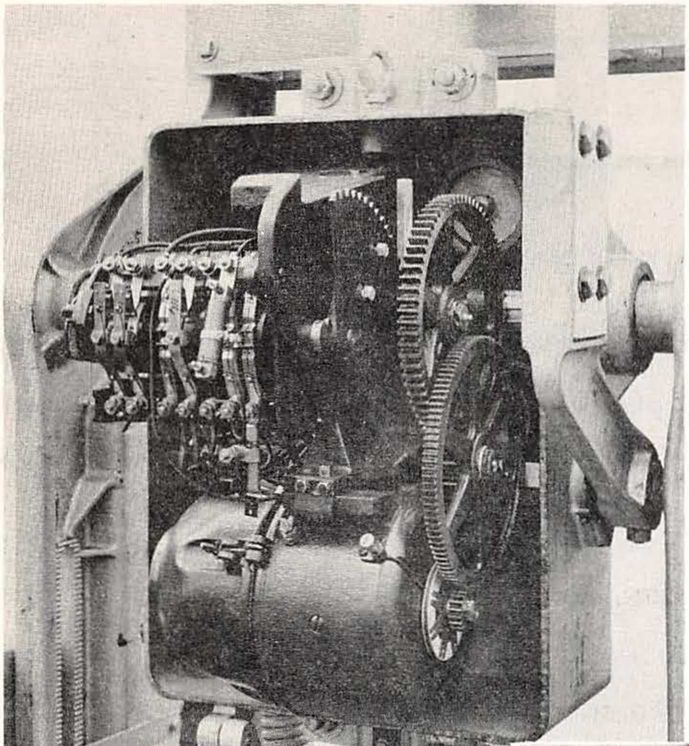


Figure 1. Type B highway crossing gate mechanism showing motor, driving clutch, gear train, and controller. Also shows how sidewalk arm is attached.

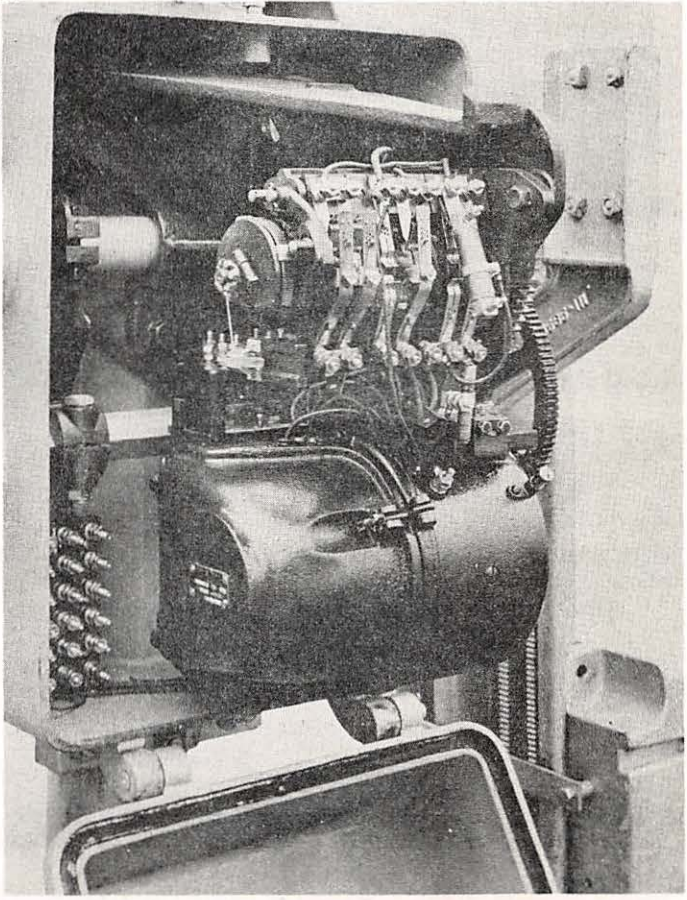


Figure 2. Type B highway crossing gate mechanism showing motor, cutout, controller, gate arm shaft and sidewalk arm shaft.

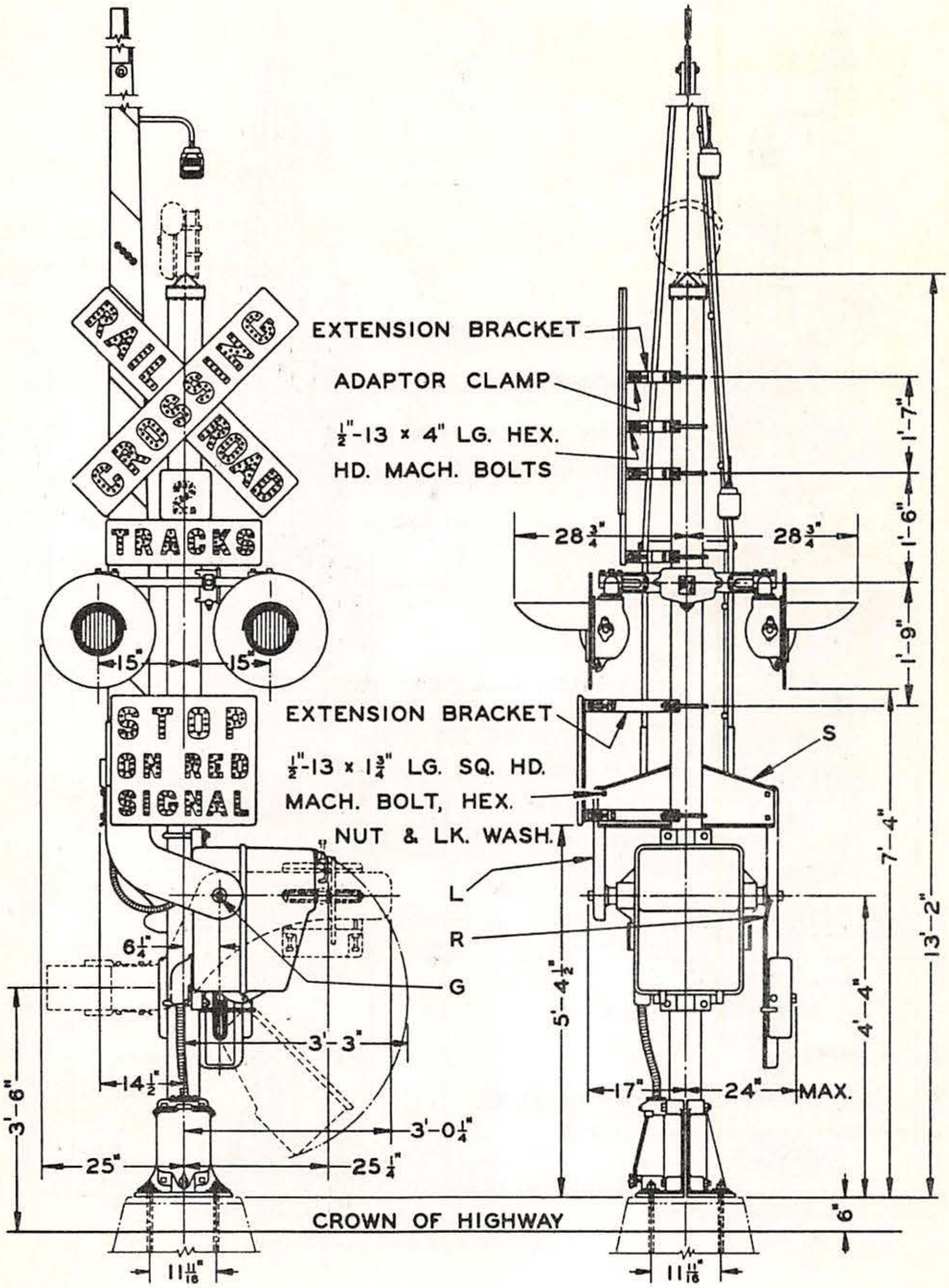

RAILROAD
CROSSING
TRACKS
STOP
ON RED
SIGNAL
EXTENSION BRACKET
ADAPTOR CLAMP
½"-13 × 4" LG. HEX.
HD. MACH. BOLTS
28¾"
28¾"
15"
15"
EXTENSION BRACKET
S
½"-13 × 1¾" LG. SQ. HD.
MACH. BOLT, HEX.
NUT & LK. WASH.
L
R
G
6¼"
3'-3"
14½"
3'-0¼"
25"
25¼"
3'-6"
17"
24" MAX.
5'-4½"
4'-4"
7'-4"
13'-2"
1'-7"
1'-6"
1'-9"
6"
CROWN OF HIGHWAY
11 11/16"
11 11/16"

Figure 3. Typical installation with gate arm up to 24 feet long, and no sidewalk arm. Note single counterweight.

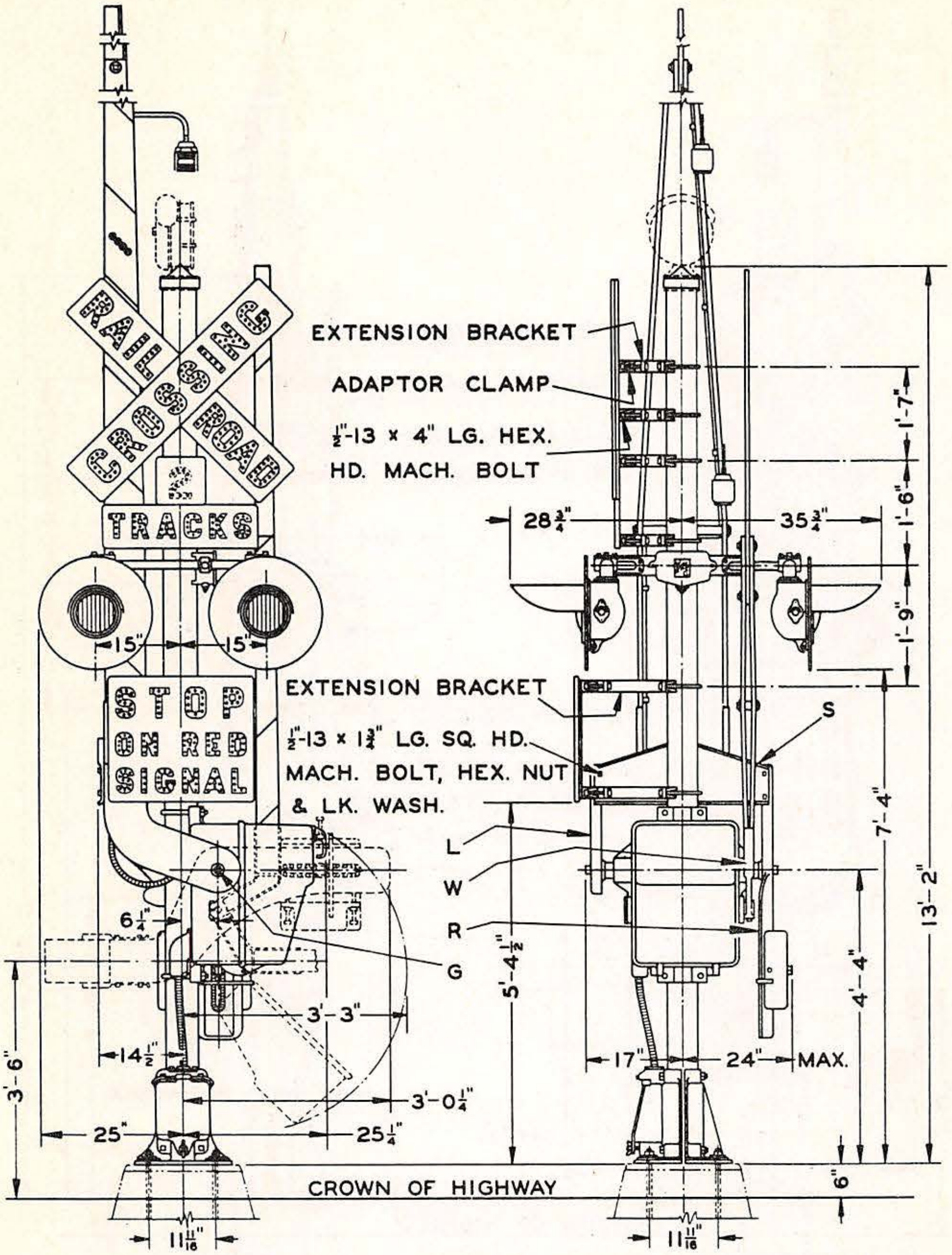

RAILROAD
CROSSING
TRACKS
15"
15"
STOP
ON RED
SIGNAL
EXTENSION BRACKET
ADAPTOR CLAMP
½"-13 × 4" LG. HEX. HD. MACH. BOLT
28¾"
35¾"
1'-7"
1'-6"
1'-9"
EXTENSION BRACKET
½"-13 × 1¾" LG. SQ. HD. MACH. BOLT, HEX. NUT & LK. WASH.
S
L
W
R
G
6¼"
3'-3"
14½"
3'-6"
3'-0¼"
25"
25¼"
5'-4½"
7'-4"
13'-2"
4'-4"
17"
24" MAX.
CROWN OF HIGHWAY
6"
11 11/16"
11 11/16"

Figure 4. Typical installation with gate arm up to 24 feet long, and with sidewalk arm. Note single counterweight.

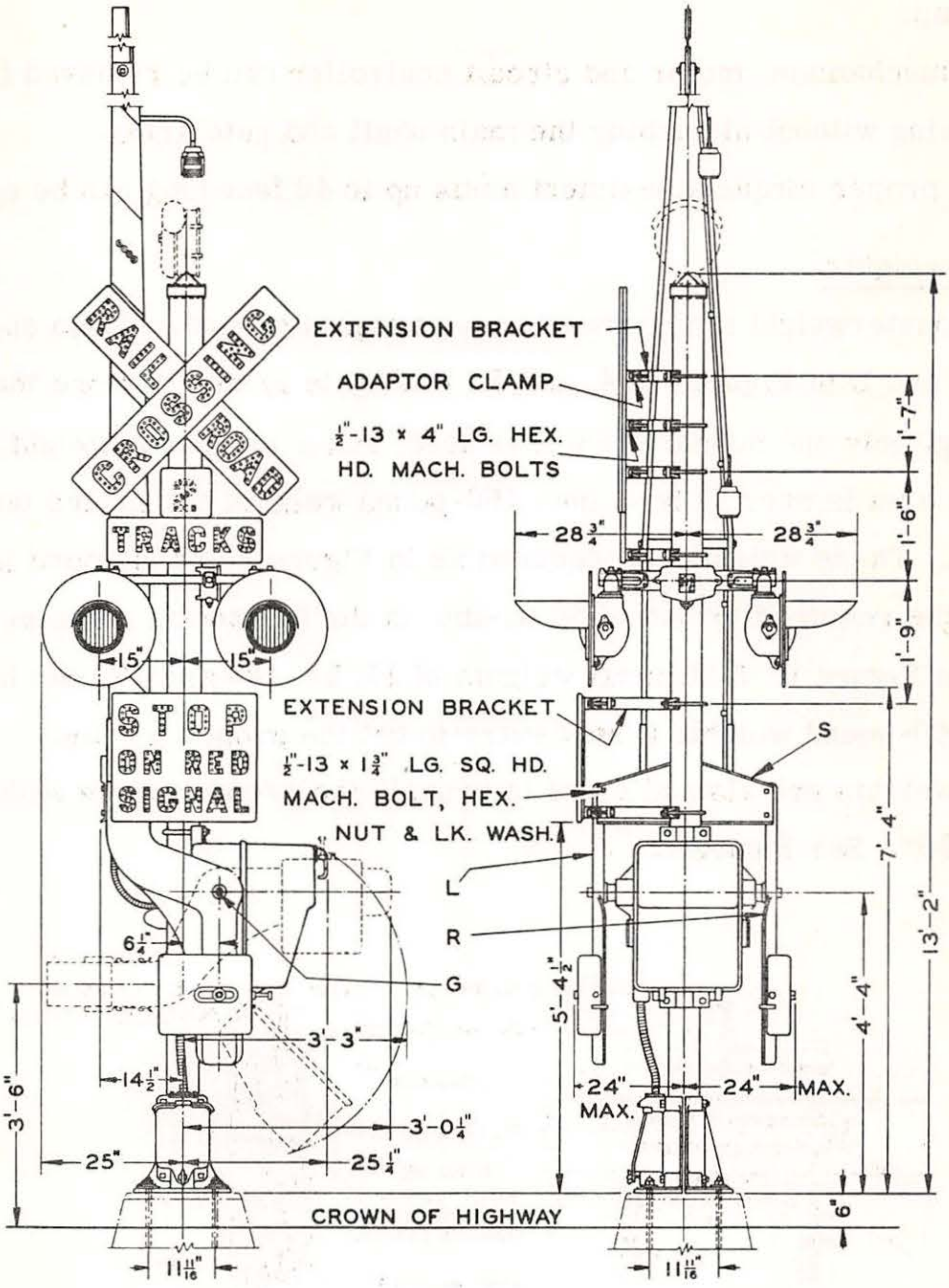

RAILROAD CROSSING
TRACKS
STOP ON RED SIGNAL
EXTENSION BRACKET
ADAPTOR CLAMP
½"-13 × 4" LG. HEX. HD. MACH. BOLTS
28¾"
28¾"
15"
15"
EXTENSION BRACKET
S
½"-13 × 1¾" LG. SQ. HD. MACH. BOLT, HEX. NUT & LK. WASH.
L
R
G
6¼"
3'-3"
14½"
3'-0¼"
25"
25¼"
3'-6"
CROWN OF HIGHWAY
11 11/16"
11 11/16"
24" MAX.
24" MAX.
5'-4½"
7'-4"
4'-4"
13'-2"
1'-7"
1'-6"
1'-9"
6"

Figure 5. Typical installation with gate arm over 24 feet long, and no sidewalk arm. Note two counterweights.

side to the other, as required. Position of arm can be adjusted by loosening clamp 2 in Figure 11, positioning arm to true horizontal and tightening clamp.

The mechanism, motor and circuit controller can be removed from the housing without disturbing the main shaft and gate arms.

With proper torque adjustment arms up to 40 feet long can be operated.

Counterweights

To counterweight the roadway arms, weights are attached to support arms R and L in Figures 3, 4, and 5. With gate arms not more than 24 feet long, only one support arm R is used, and a 160-pound weight. If the gate arm is over 24 feet long, 160-pound weights are placed on arms R and L. These weights are secured as in Figure 6 and clamped in place to give the required torque of 50 ft.-lbs. in the horizontal position, as shown in Figure 7. Additional weights of 25, 50, 100 and 200 can be bolted on the 160-pound weights if necessary to get the proper torque.

The weights are also adjusted to provide the proper torque with the gate at 90°. See Figure 8.

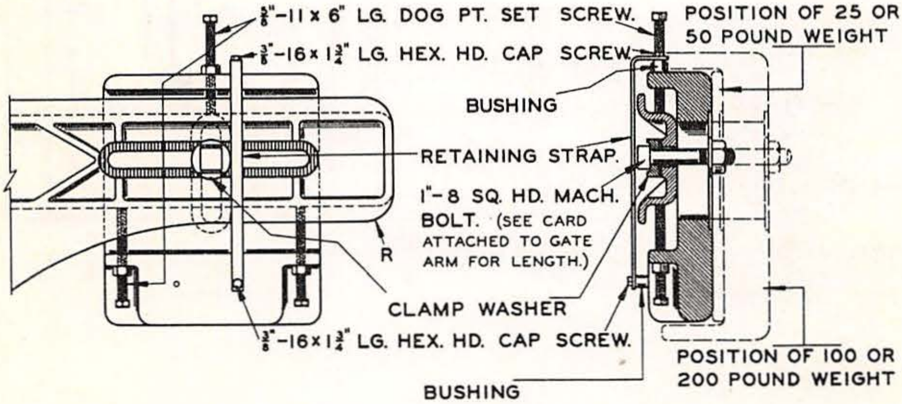
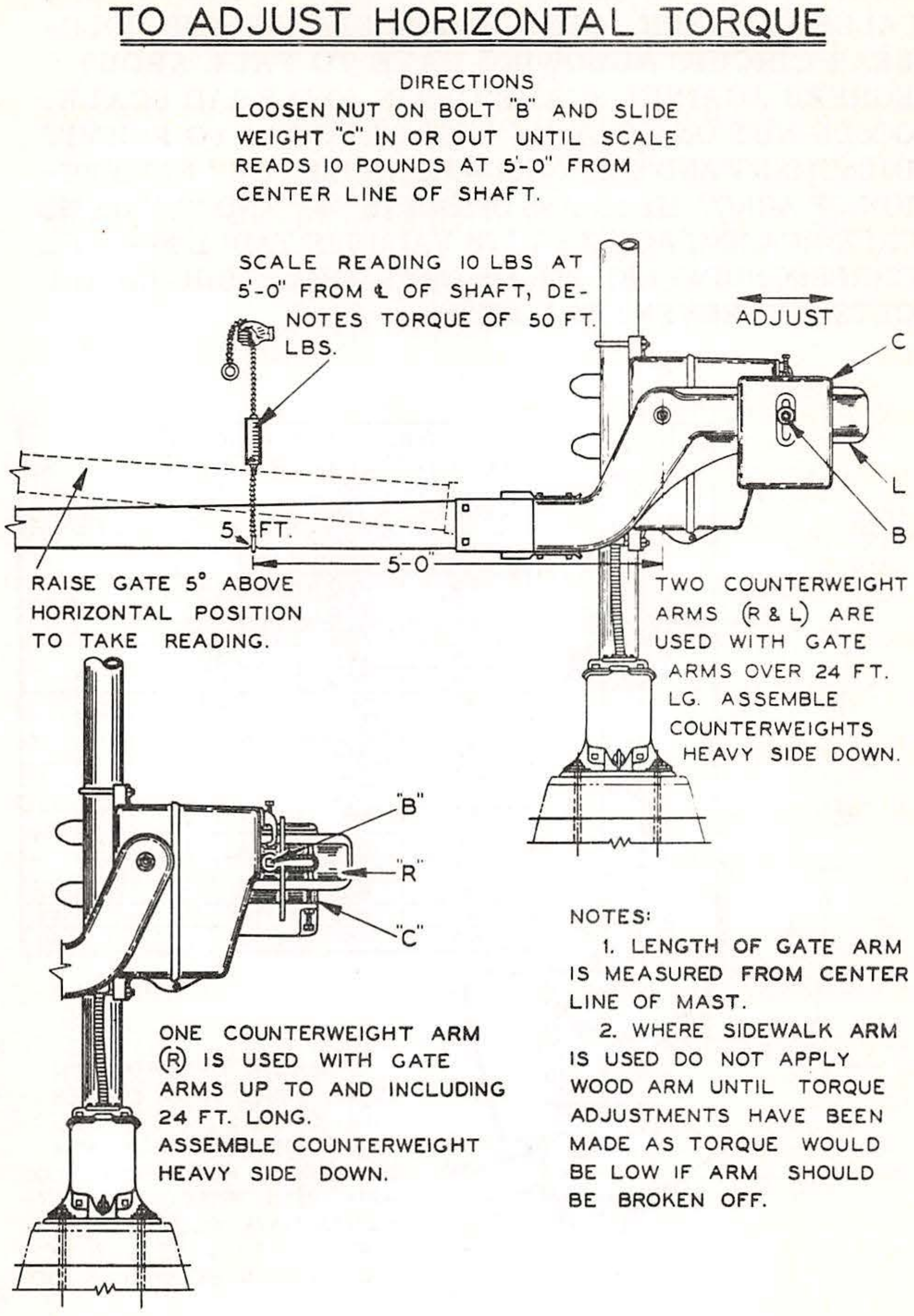

5/8"-11 x 6" LG. DOG PT. SET SCREW.
3/8"-16 x 1 3/4" LG. HEX. HD. CAP SCREW.
POSITION OF 25 OR 50 POUND WEIGHT
BUSHING
RETAINING STRAP.
1"-8 SQ. HD. MACH. BOLT. (SEE CARD ATTACHED TO GATE ARM FOR LENGTH.)
R
CLAMP WASHER
3/8"-16 x 1 3/4" LG. HEX. HD. CAP SCREW.
POSITION OF 100 OR 200 POUND WEIGHT
BUSHING

Figure 6. Method of attaching counterweight.



TO ADJUST HORIZONTAL TORQUE

DIRECTIONS

LOOSEN NUT ON BOLT "B" AND SLIDE WEIGHT "C" IN OR OUT UNTIL SCALE READS 10 POUNDS AT 5'-0" FROM CENTER LINE OF SHAFT.

SCALE READING 10 LBS AT 5'-0" FROM ℄ OF SHAFT, DENOTES TORQUE OF 50 FT. LBS.

RAISE GATE 5° ABOVE HORIZONTAL POSITION TO TAKE READING.

TWO COUNTERWEIGHT ARMS (R & L) ARE USED WITH GATE ARMS OVER 24 FT. LG. ASSEMBLE COUNTERWEIGHTS HEAVY SIDE DOWN.

ONE COUNTERWEIGHT ARM (R) IS USED WITH GATE ARMS UP TO AND INCLUDING 24 FT. LONG. ASSEMBLE COUNTERWEIGHT HEAVY SIDE DOWN.

NOTES:

1. LENGTH OF GATE ARM IS MEASURED FROM CENTER LINE OF MAST.
2. WHERE SIDEWALK ARM IS USED DO NOT APPLY WOOD ARM UNTIL TORQUE ADJUSTMENTS HAVE BEEN MADE AS TORQUE WOULD BE LOW IF ARM SHOULD BE BROKEN OFF.

Figure 7. How to adjust torque in horizontal position.

TO ADJUST CLEAR TORQUE

ALLOW SIGNAL TO CLEAR AND LATCH. ATTACH SPRING SCALES AS SHOWN. OPEN MOTOR CIRCUIT AND HOLD-CLEAR CIRCUIT ALLOWING GATE TO FALL ABOUT 5 DEGREES AGAINST SCALE CHAIN AND READ SCALE. LOOSEN NUT ON BOLT "B" JUST ENOUGH TO PERMIT ADJUSTMENT AND SHIFT COUNTERWEIGHT "C" IN DIRECTION OF ARROW BY MEANS OF BOLTS "A" AND "D" UNTIL SCALE READING AGREES WITH VALUE IN TABLE FOR THE CORRESPONDING LENGTH OF GATE ARM. TIGHTEN ALL BOLTS TO PREVENT SLIPPING.

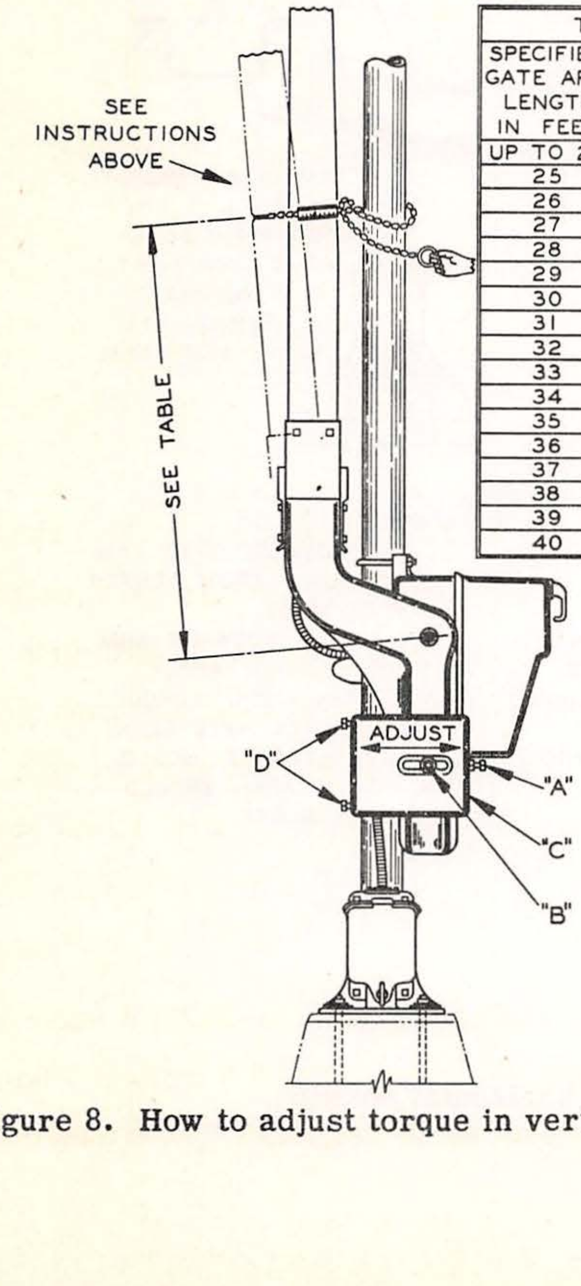


TABLE OF TORQUE VALUES

SPECIFIED GATE ARM LENGTH IN FEET	CLEAR TORQUE IN FOOT POUNDS	SCALE READING IN LBS. AT DISTANCE SHOWN FROM ℄ OF BEARING				
		5 FT.	7 FT.	8 FT.	9 FT.	10 FT.
UP TO 24	200	40				
25	220	44				
26	240	48				
27	250	50				
28	266		38			
29	280		40			
30	301		43			
31	308		44			
32	315		45			
33	343		49			
34	369				41	
35	387				43	
36	405				45	
37	432				48	
38	450				50	
39	470					47
40	480					48

NOTES:

1. LENGTH OF GATE ARM IS MEASURED FROM CENTER LINE OF MAST.
2. WHERE SIDEWALK ARM IS USED DO NOT APPLY WOOD ARM UNTIL TORQUE ADJUSTMENTS HAVE BEEN MADE AS TORQUE WOULD BE LOW IF ARM SHOULD BE BROKEN OFF.

Figure 8. How to adjust torque in vertical position.

Stops

Adjustable spring stops are provided for 0° and 90°, as shown in Figure 9, and are protected by covers. For horizontal adjustment loosen lock nut B, place a 3/8 inch round bar in the hole on the end of screw A, adjust for 0° position, and retighten nut B, holding nut C. For vertical adjustment, loosen lock nut G, adjust screw F with 3/8 round bar, retighten nut G, holding nut H. Raise and lower gate by power to check.

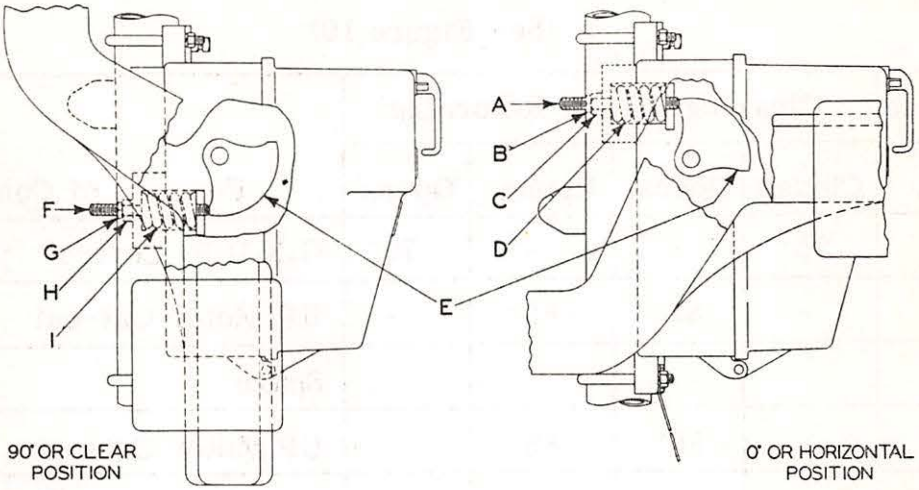


Figure 9. Stop adjustment.

Gear Train

Gear train is similar to the Model 2A semaphore gear train. The motor pinion drives an intermediate gear which in turn drives a second intermediate gear which then drives the sector gear on the gate arm shaft. Total gear reduction is 220:1 between motor shaft and gate shaft.

The first intermediate gear is press fitted to a shaft carried on a roller bearing. The second intermediate gear is also press fitted on a shaft that rides on needle bearings.

Circuit Controller

In mesh with the small pinion of the second intermediate, a second sector gear drives the circuit controller cams. The controller, Figure 10, is similar to the one used on Model 2A semaphores. Fourteen contact spaces are provided. Six of these are for control of the gate mechanism. The rest can be used for auxiliary circuits such as bells, gate lights, and indicator lights (when gates are manually controlled).

A counter E is attached to the controller frame to count the number of gate operations.

CIRCUIT CONTROLLER OPERATION AND FUNCTIONS

(See Figure 10)

Contact Space No.	Clearing		Returning		Function of Contact
	Closes	Opens	Closes	Opens	
1	75°	-	-	75°	G.X.P.R. Control
2	-	88°	85°	-	UP Motor Cut-out
3					Spare
4	-	88°	85°	-	UP Motor Cut-out
5	-	85°	85°	-	Flasher Relay Control
6	-	75°	75°	-	Hold Clear Control
7	-	85°	85°	-	Light Control
8	45°	-	-	45°	Down Motor Cut-out
9	3°	-	-	3°	Bell Control
10					Spare
11	-	85°	85°	-	Indication Light
12	-	10°	10°	-	Snub. Res. Shunt
13	-	85°	85°	-	Indication Light
14	-	44°	44°	-	0° - 44° Snubbing Contact

Contacts 14 and 8 not used for gravity return.

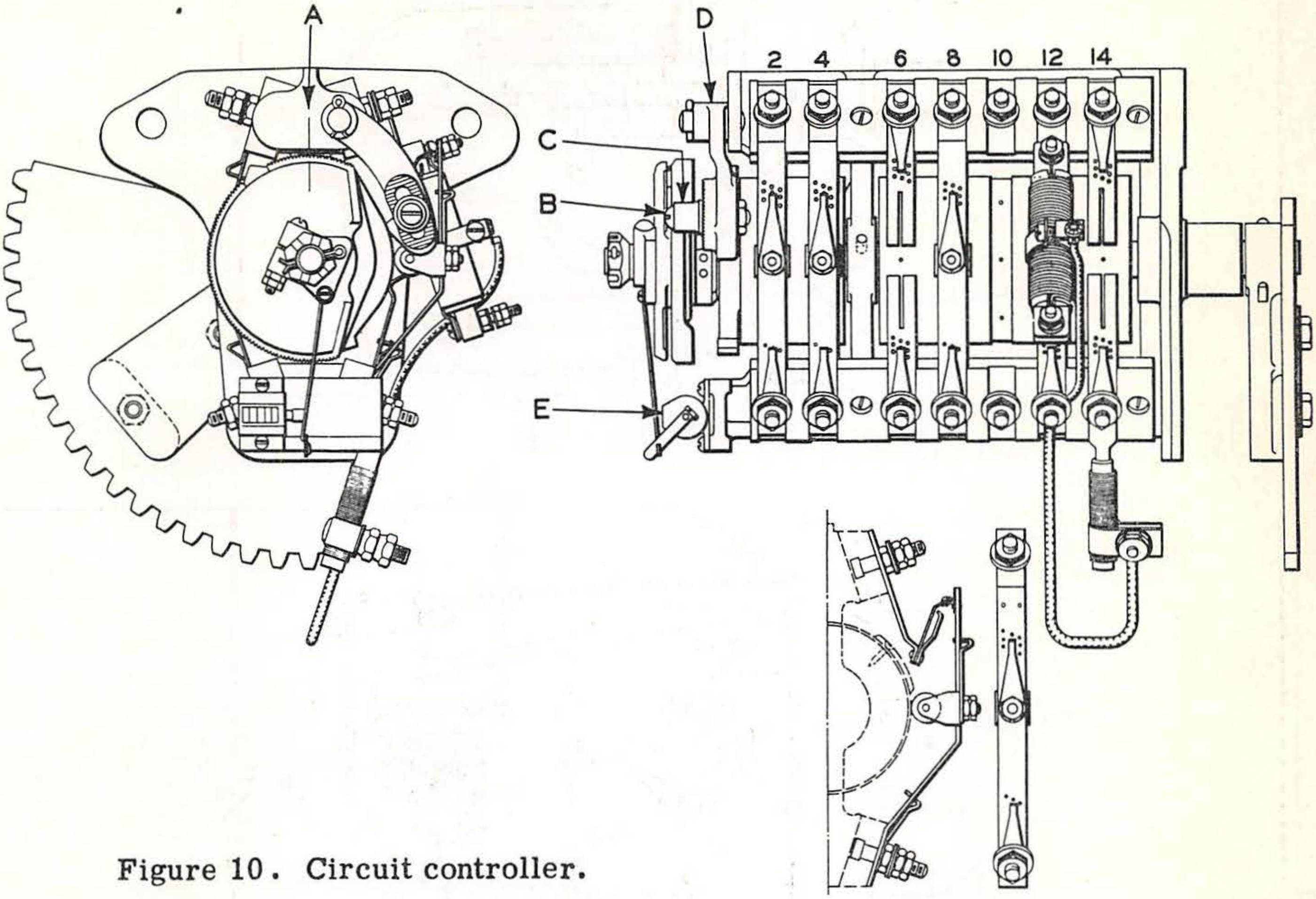


Figure 10. Circuit controller.

Motor Cutout

If the gate arm does not drive by power to the correct clear position, knob C on arm D, Figure 10, can be changed to stop the gate arm in the correct position.

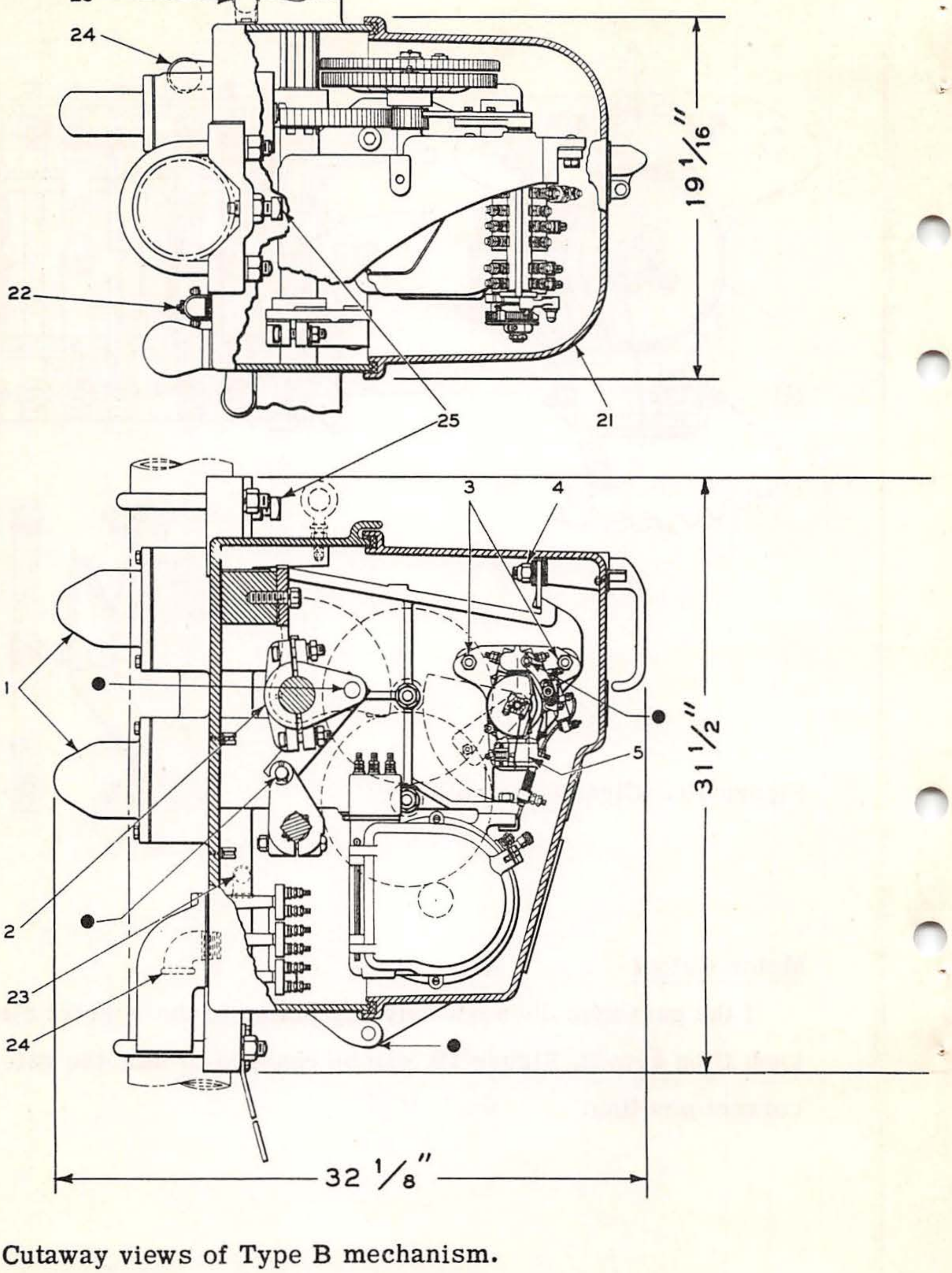
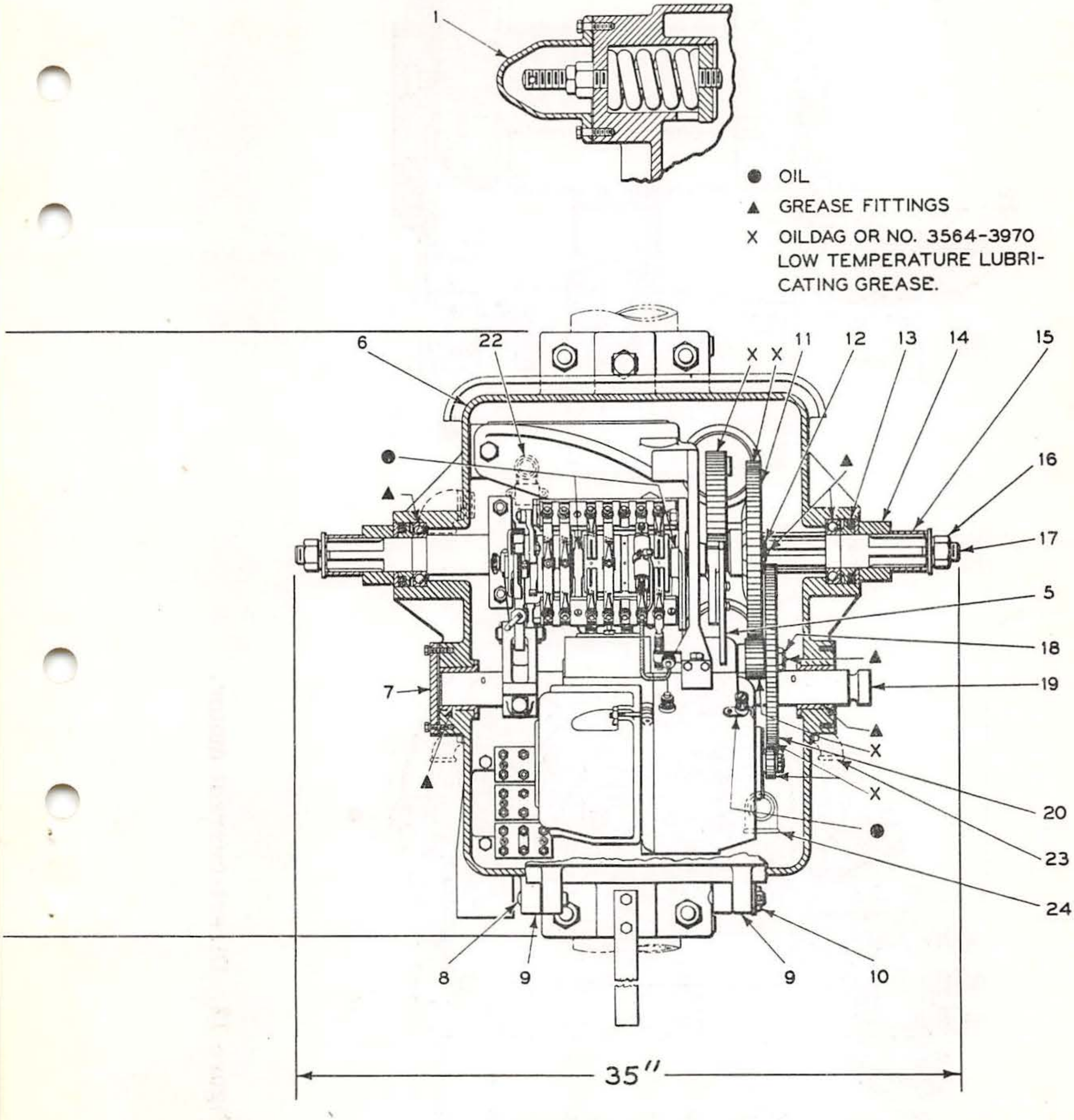

23
24
22
25
21
19 1/16"
3
4
1
2
5
31 1/2"
23
24
32 1/8"

Figure 11. Cutaway views of Type B mechanism.


● OIL
▲ GREASE FITTINGS
X OILDAG OR NO. 3564-3970 LOW TEMPERATURE LUBRICATING GREASE.
X X
X
X
35″

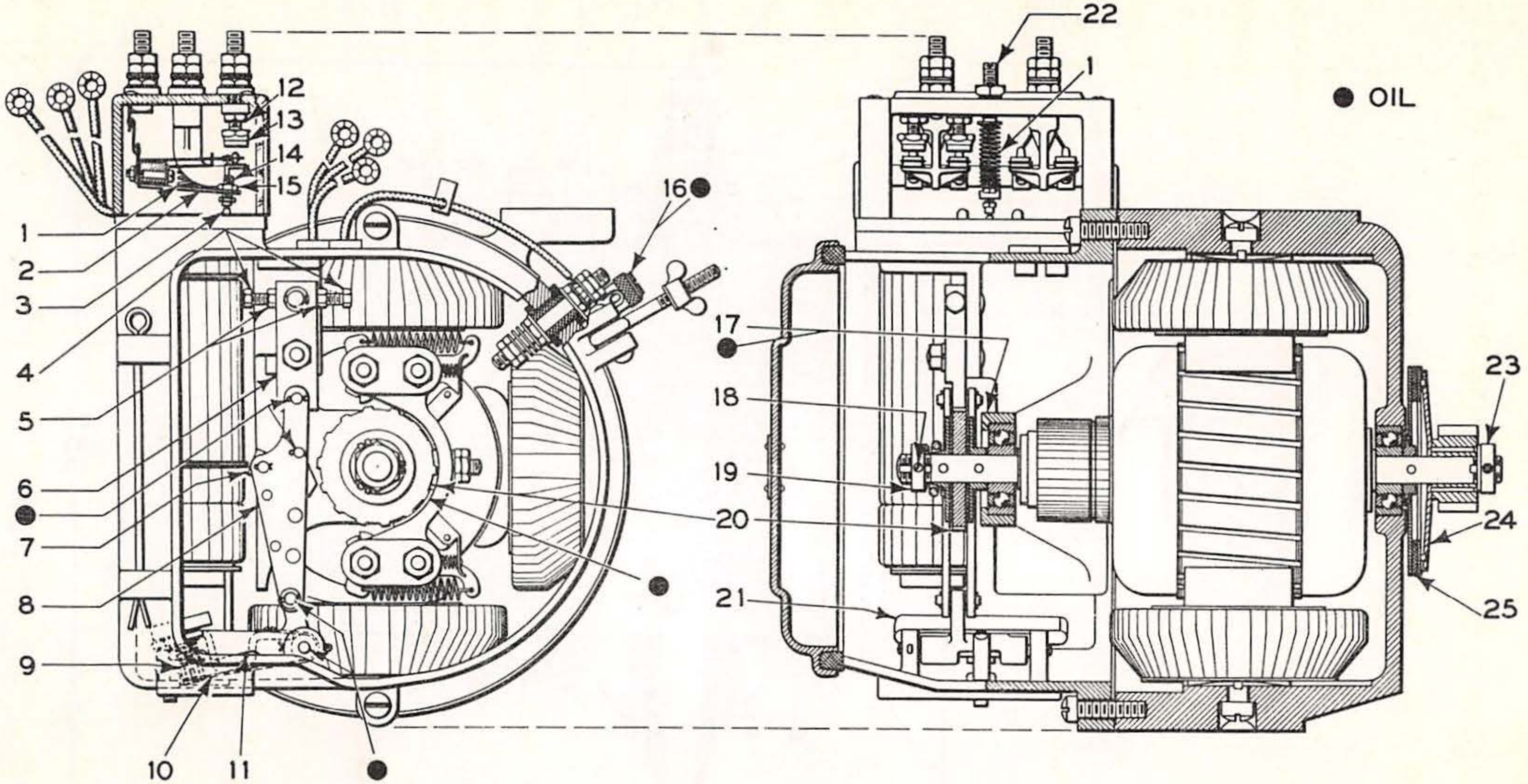

22
12
13
14
15
1
2
3
4
5
6
7
8
9
10
11
16
17
18
19
20
21
23
24
25
● OIL

Figure 12. Direct-current motor.

Descending Time

The descending time of the arm can be regulated by adjusting resistance units attached to the upper binding post in space 12 and the lower binding post in space 14.

Motor

The motor is similar to the one used in Model 2A semaphores d-c., four-pole, with six field windings. When gates are raised the motor is series connected with the four up-field windings in series - multiple. When gates are lowered by power the motor is series connected with the two down-field windings in series. Power for driving down is cut off at 45°. From 44° to 0° the snub resistor is cut in across the armature and up-field windings.

Friction Clutches

There are two friction clutches on the motor shaft. The one on the commutator end is the hold-clear clutch. The one on the pinion end is the driving clutch.

The function of the hold-clear clutch is to prevent strain on the mechanism when the gate arm drops onto the hold-clear disc 20, Figure 12. After clearing, a slight movement of the disc should result, approximately one-half the distance between the teeth on the disc. The clutch is adjusted by loosening screw 18 and turning nut 19 to increase or decrease friction applied to disc 20.

Friction clutch 25 on the pinion end of the motor shaft prevents undue strain on the motor and mechanism should the gate arm be broken off and the gears driven by the counterweights against the 90° stop. The clutch should slip when a force of 5 to 6 pounds is applied to the pinion at a radius of 1 foot with the motor shaft held rigid. The clutch is adjusted by loosening the set screw and turning nut 23 to increase or decrease compression on spring 24.

Hold Clear

The hold clear is similar to the one on Model 2A semaphores. See Figure 12.

With armature 21 picked up the tip of dog 7 engages ratchet step on the rim of hold-clear disc 20. It should clear the bottom or root of the ratchet step by 0.010 inch. Adjustment is made by adjusting hanger block 6 by screws 4.

With armature 21 released the tip of dog 7 should clear the holding teeth of disc 20 by 0.020 to 0.025 inch. This adjustment is made by adjusting stop 9.

On top of the hold-clear is a contactor operated by hold-clear armature 21 through push rod 3. Contacts select direction of rotation of motor by energizing either the up-field or the down-field windings; also select the snub circuit.

The dropaway voltage should not be less than 3.25 volts. It can be adjusted by changing the pressure on spring 1, which must not be made so tight that the armature will not pick up on 8 volts.

Clearing Time

The gate should clear from 0° to 90° in 10 to 15 seconds.

Gate Arm Length (Feet)	Clearing Time (Seconds)
Up to 24	11
25 to 36	10 to 15
37 to 40	13 to 15

Wire Size

Size of wire used for the motor circuit should be selected so that there is not more than 0.1 ohm between battery and mechanism terminals.

The following wire sizes are recommended:

Distance between Battery and Mechanism Terminals	Soft Drawn Copper Wire
Up to 60 feet (120 feet of wire)	No. 9 AWG
From 60 to 120 feet (240 feet of wire)	No. 6 AWG

Battery

The following battery is recommended with the above wire for gates of various lengths:

Gate Arm Length (feet)	Clear Position Torque (foot-pounds)	Number of Cells Lead Storage	Ni-Fe Storage
Up to 24	200	6	9
25 to 36	220 to 405	7	11
37 to 40	432 to 480	8	12

Lubrication

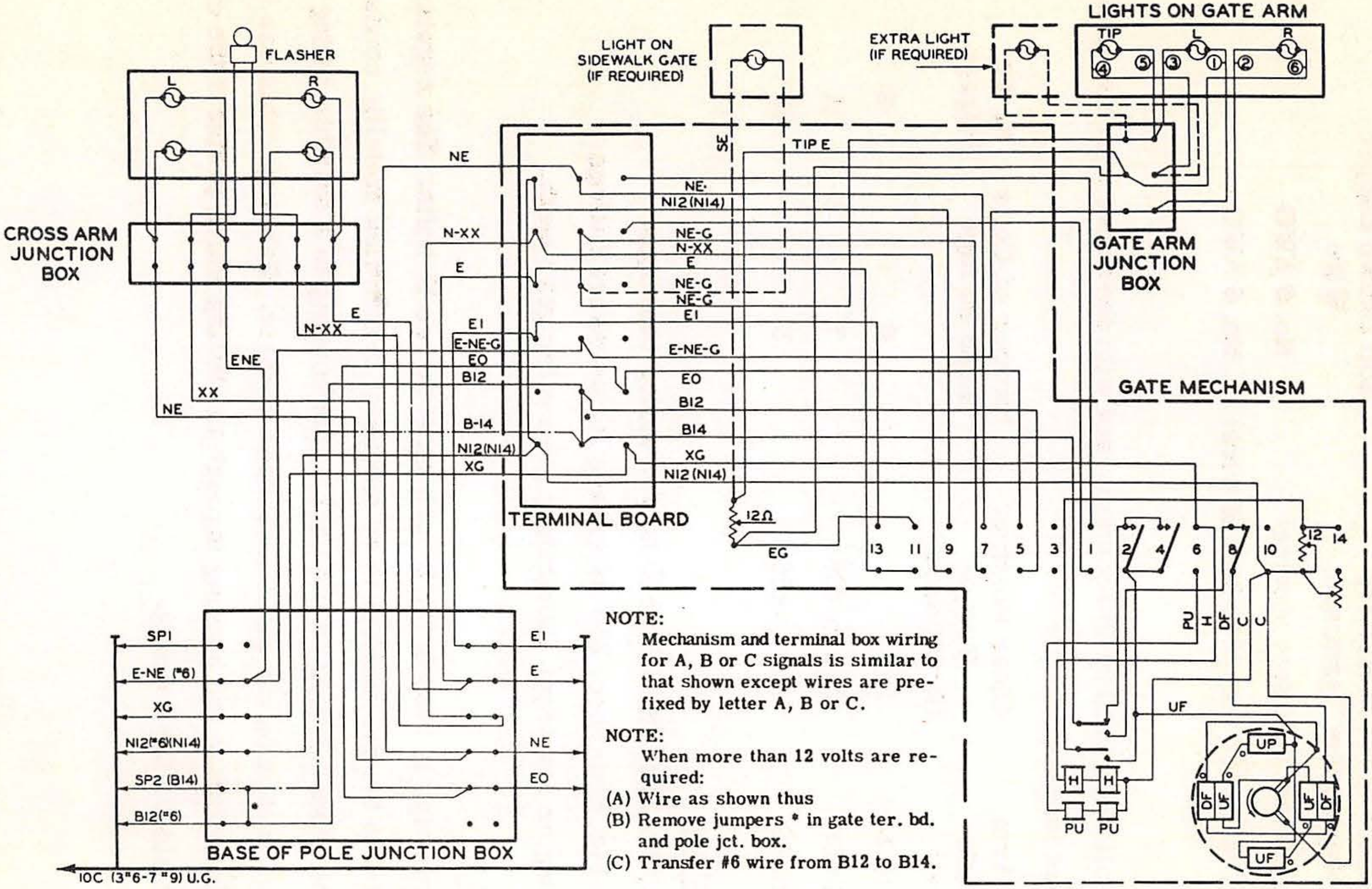
AAR Sig. Sec. Spec. 103-40 oil for motor bearings.

AAR Sig. Sec. Spec. 250-49 grease for pressure fittings.

Oil dag or low temp. lubricating grease for gear teeth.

Housing

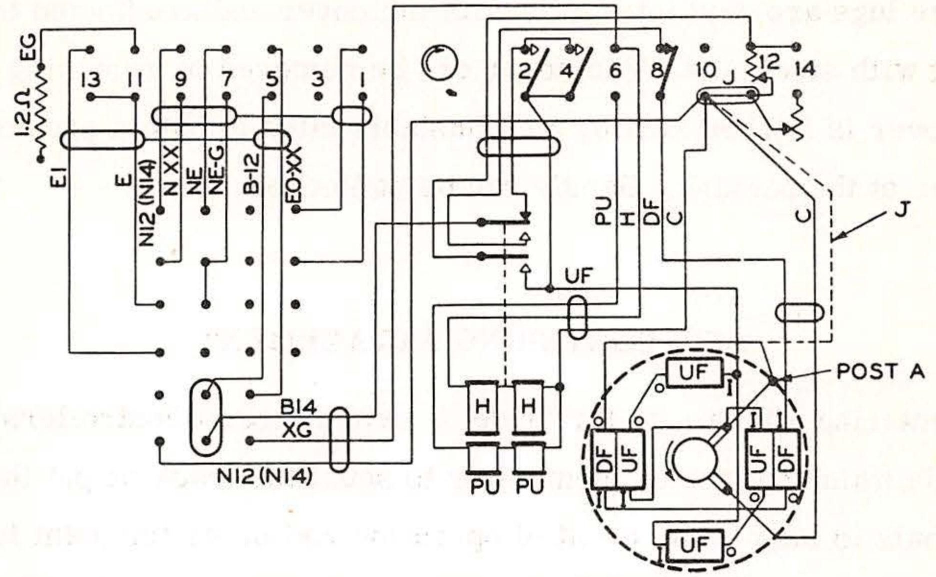
The housing is held to the 5-inch mast by two U-bolts. The regular wire inlet to the mechanism is by means of 2-inch flex metallic conduit extending from a fitting on the back of the housing to a suitable fitting on a junction box on the mast or at base of mast. Parkway cable can be brought directly to the housing through the fitting which protects the cable where it enters the housing.


FLASHER
L
R
CROSS ARM JUNCTION BOX
LIGHT ON SIDEWALK GATE (IF REQUIRED)
EXTRA LIGHT (IF REQUIRED)
LIGHTS ON GATE ARM
TIP
L
R
GATE ARM JUNCTION BOX
NE
N-XX
E
SE
TIP E
NE-
N12 (N14)
NE-G
N-XX
E
NE-G
NE-G
E1
E-NE-G
EO
B12
B14
XG
N12 (N14)
E1
E-NE-G
EO
B12
B-14
N12(N14)
XG
E
N-XX
ENE
XX
NE
TERMINAL BOARD
12Ω
EG
GATE MECHANISM
13 11 9 7 5 3 1 2 4 6 8 10 12 14
PU H DF C C
UF
UP
DF UF UF DF
UF
H H
PU PU
SP1
E-NE (#6)
XG
N12(#6)(N14)
SP2 (B14)
B12(#6)
E1
E
NE
EO
BASE OF POLE JUNCTION BOX
10C (3#6-7#9) U.G.

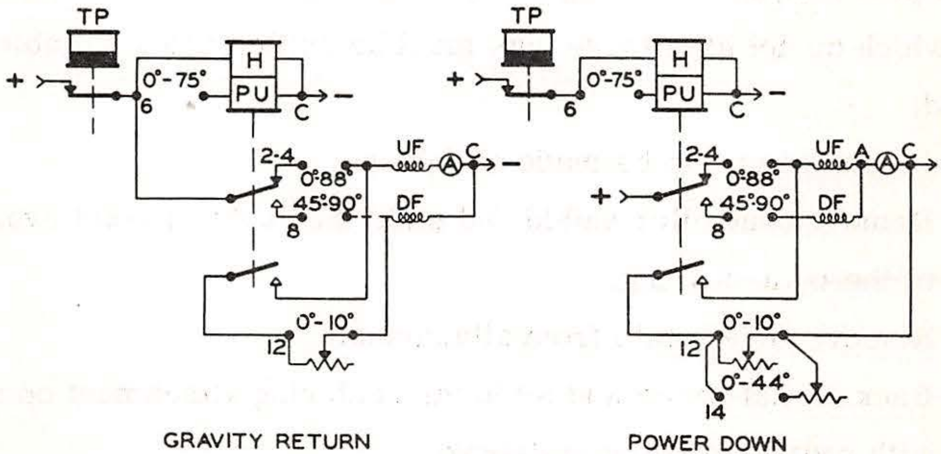
NOTE:
Mechanism and terminal box wiring for A, B or C signals is similar to that shown except wires are prefixed by letter A, B or C.

NOTE:
When more than 12 volts are required:
(A) Wire as shown thus
(B) Remove jumpers * in gate ter. bd. and pole jct. box.
(C) Transfer #6 wire from B12 to B14.

Figure 13. Detailed wiring for a typical installation.


EG
1.2Ω
E1
13
11
E
9
N12 (N14)
N XX
7
NE
NE-G
5
B-12
3
EO-XX
1
2
4
6
8
10
J
12
14
PU
H
DF
C
J
UF
POST A
B14
XG
N12 (N14)
H
H
PU
PU
UF
DF
UF
UF
DF
UF

MECHANISM SHOWN IN CLEAR POSITION


TP
+
6
0°-75°
H
PU
C
-
2-4
0°-88°
45°-90°
8
UF
DF
A
C
-
0°-10°
12
TP
+
6
0°-75°
H
PU
C
-
2-4
0°-88°
+
45°-90°
8
UF
A
A
C
DF
0°-10°
12
0°-44°
14

GRAVITY RETURN POWER DOWN

MECHANISM WIRED FOR POWER DOWN

NOTE 1: To change from power down to gravity return proceed as follows:-

1 - Remove jumper "J" from lower posts in spaces 10 and 12.

2 - Remove down field lead from lower post in space 8 and connect to lower post in space 12.

3 - Remove wire from post "A" on motor frame and connect to lower post in space 10. (Wire shown in dash lines.)

4 - Remove resistor in space 14.

5 - Adjust snubbing resistance to meet requirements.

NOTE 2: Returning from 90° latch arm must drop into latching plate between 77° and 80°.

NOTE 3: Wires shown encircled to be made up in separate cables.

Figure 14. Typical circuits.

Cover

Hinge lugs are cast integrally with the cover and are hinged to the housing with steel pins. The cover can be removed by removing a cotter pin. Cover is latched shut by an adjustable latch to obtain proper compression of the packing. Handle can be padlocked.

* * *

NEW CENTERING ATTACHMENT

A centering attachment for Model 8 switch circuit controllers is now available which causes the controller to shunt the track or put the governing signals to stop in the event of operating rod or switch point lug failure.

The attachment, 53231-2, can be applied in the field to Model 8 controllers which have a lug on each side of the case below the main bearings. The lug prevents the centering attachment from turning on the shaft. Cases which do not have these lugs must be drilled and a suitable lug attached.

Field installation can be made as follows:

(1) Remove controller shield and slide the rubber gasket over the end of the main bearing.

(2) Remove cover plate from attachment.

(3) Back off set screw and slide the centering attachment on shaft, with switch points in midstroke.

(4) Tighten set screw and lock nut.

(5) Replace cover.

GENERAL RAILWAY SIGNAL COMPANY

AUTOMATIC TRAIN IDENTIFICATION AND ROUTING SYSTEM

There are, on practically all railroads, locations at which trains must be switched to one or another of diverging routes. In order for a tower operator to line up the proper routes for such trains, he must, of course, know the identity of each train and its intended destination. On rapid transit lines, and on railroads operating commuter trains, this matter of train identification and routing can present a real problem, because traffic is heavy and trains follow each other at short intervals. A tower operator who has to identify such trains by means of their marker lights, by telephone messages, or by other means, and who must then set up the proper route for each, may find it difficult to keep up with the flow of traffic. It may happen, therefore, that delays occur in lining up routes and even, occasionally, that trains get mis-routed and have to be backed-up, giving rise to serious delays. Recognizing this problem, G-R-S has developed an automatic train describer and routing system by which each train identifies itself and lines up its own route without the attention of the operator.

The new system identifies trains by making use of the properties of a vacuum-tube oscillator. Now, an oscillator is really an a-c. generator which produces high-frequency energy, and Figure 1a shows in symbolic form such an oscillator with the voltage it generates. The symbols labelled L1 and C1 represent, respectively, a fixed coil and a variable condenser making up a tuned circuit which determines the oscillator frequency. Varying C1 varies the oscillator frequency but does not affect the voltage generated. Let us assume that C1 in Figure 1a is set at the position which produces 100-kc. output (100,000 cycles per second), and that by varying C1 we can shift the frequency between the limits of 85 kc. and 115 kc.

Now let us perform an experiment with this oscillator. Let us construct a loop, which we'll call the "A" loop, made up of a coil, L2, tuned to 100 kc. by means of a condenser, C2, and then place this loop near L1 of the oscillator. The result is shown in Figure 1b; the output voltage of the oscillator is sharply reduced. What has happened is that the "A" loop is absorbing energy through the magnetic coupling between L1 and L2, and the oscillator, acting like a generator with poor regulation under load, cannot keep its voltage up.

If we continue our experiment further, we find that the effect of the "A" loop depends upon the distance between L2 and L1, and upon how L2 and L1 are lined up with respect to each other. With L2 and L1 properly alined, we find that we can produce a marked drop in the oscillator output even when the coils are separated by a considerable distance.*

Now let us construct another loop, made up of a coil, L3, tuned by a condenser, C3, so that it is resonant at 90 kc. Call this new loop the "B" loop and substitute it for the "A" loop, as shown in Figure 1c. We discover that the "B" loop has practically no effect on the oscillator, even when we place it closer to L1 than we had the "A" loop. But suppose we re-adjust C1 so that the oscillator frequency becomes 90 kc. The output (Figure 4d) immediately drops to the low level we noted previously with the "A" loop and the oscillator at 100 kc. We conclude, therefore, that the oscillator reacts to the presence of an external loop only when the oscillator is tuned to the same frequency as the loop.

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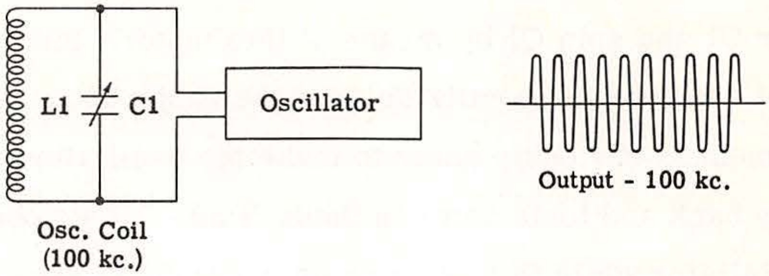
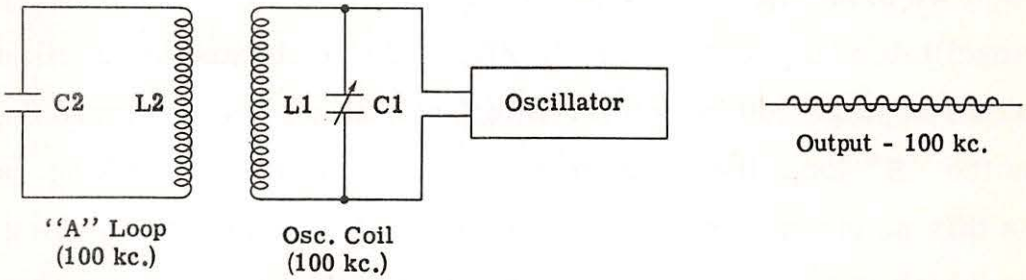
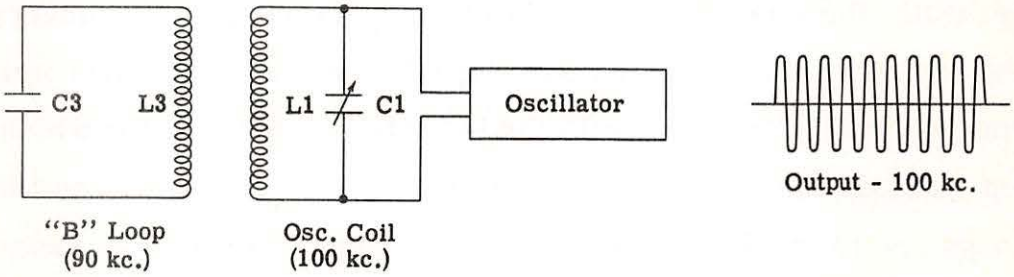
*The distance over which this effect is produced depends to a large extent on the coil diameter. Marked loading of the oscillator occurs at distances as great as 1-1/2 times the coil diameter, or 18 inches with a 12-inch coil.


L1
C1
Oscillator
Output - 100 kc.
Osc. Coil
(100 kc.)

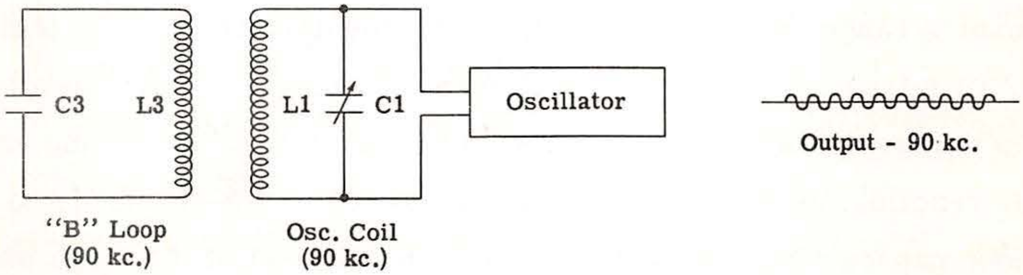
a. No external loop


C2
L2
L1
C1
Oscillator
Output - 100 kc.
"A" Loop
(100 kc.)
Osc. Coil
(100 kc.)

b. External loop tuned to oscillator frequency


C3
L3
L1
C1
Oscillator
Output - 100 kc.
"B" Loop
(90 kc.)
Osc. Coil
(100 kc.)

c. External loop tuned to frequency different from oscillator


C3
L3
L1
C1
Oscillator
Output - 90 kc.
"B" Loop
(90 kc.)
Osc. Coil
(90 kc.)

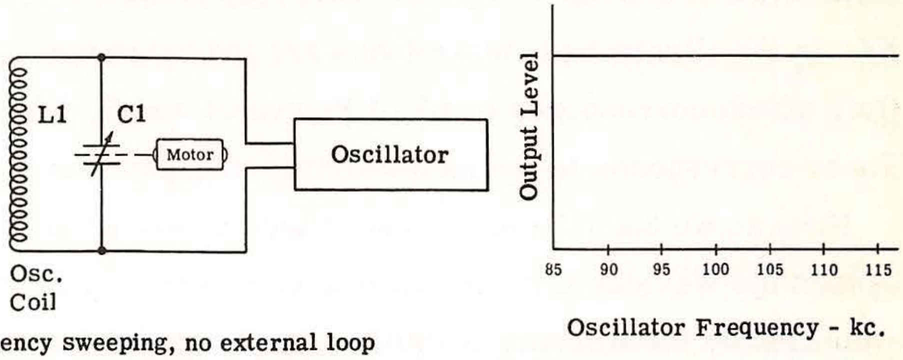
d. Oscillator re-tuned to loop frequency

Figure 1. Effects of tuned loops on oscillator output.

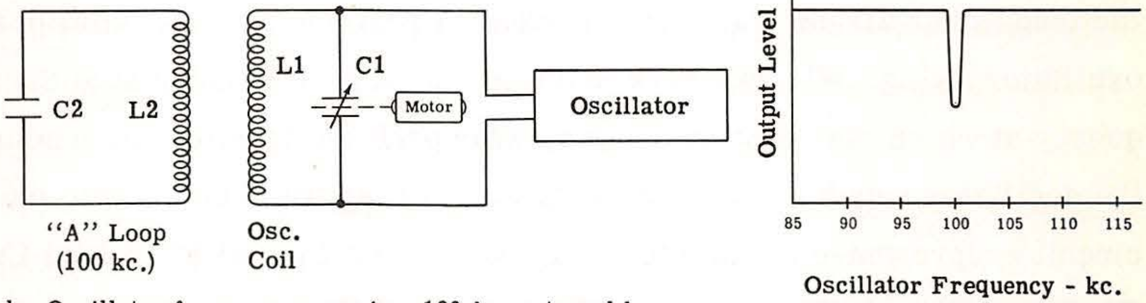
Suppose next that we connect an electric motor to oscillator tuning condenser C1 and spin C1 by means of this motor. Since we already know that C1 can tune the oscillator over the range 85 kc. to 115 kc., this arrangement is obviously going to make the oscillator frequency sweep rapidly back and forth between these limits. If we observe the output of the oscillator while this is going on, we find, as shown in Figure 2a, that even though the frequency is varying, the output level stays constant.

Now if we bring the "A" loop near L1, there will be a momentary drop in the oscillator output, as shown in Figure 2b, each time the oscillator sweeps through the 100-kc. point. Similarly, as we see in Figure 2c, if we use the "B" loop, the momentary reaction occurs at the 90-kc. point.

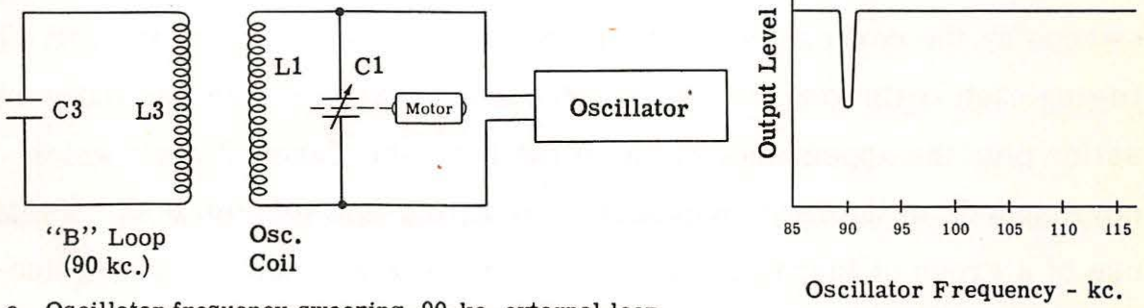
It is this momentary reaction of an external loop upon a sweeping oscillator which is used in the new train identification and routing system. Each train to be identified carries a tuned loop, mounted on the side of, or underneath, the locomotive or leading car; the resonant frequency of this loop identifies the train. At some location ahead of the first switch in the interlocking plant, an oscillator is installed, the coil for which is mounted - beside the track, or between the rails, depending on how the train loops are carried - in such a position that the train loops pass within 18 inches of it as the trains move past. By means of a motor-driven variable condenser the oscillator frequency is swept rapidly back and forth over a range which includes all the frequencies used in the train loops. This frequency sweep is so rapid (120 times a second) that the loops on even the fastest-moving trains cannot slip by without producing an oscillator reaction, as might occur if a slow sweep rate were used and the train loop passed while the oscillator was in that part of its range which did not include the loop frequency. A passing train thus identifies itself by the frequency at which its loop produces a reaction in the wayside oscillator, and this information is then utilized by means of suitable circuits


L1
C1
Motor
Oscillator
Osc.
Coil
Output Level
85
90
95
100
105
110
115
Oscillator Frequency - kc.

a. Oscillator frequency sweeping, no external loop


C2
L2
"A" Loop
(100 kc.)
L1
C1
Motor
Oscillator
Osc.
Coil
Output Level
85
90
95
100
105
110
115
Oscillator Frequency - kc.

b. Oscillator frequency sweeping, 100-kc. external loop


C3
L3
"B" Loop
(90 kc.)
L1
C1
Motor
Oscillator
Osc.
Coil
Output Level
85
90
95
100
105
110
115
Oscillator Frequency - kc.

c. Oscillator frequency sweeping, 90-kc. external loop

Figure 2. Effects of tuned loops on sweep-frequency oscillator.

to line up the proper route for the train.

For more detailed information on how this is done, let us consider Figure 3. Figure 3 is a block diagram showing the organization of a train identification system using four train loop frequencies: F1, F2, F3, and F4. In the illustration, these loops are indicated moving past a Wayside Coil, which corresponds to L1 of Figures 1 and 2. The block labelled Tuner corresponds to the motor-driven condenser of Figure 2.

Now, as we know from our experiments, when one of the train loops passes the Wayside Coil, it will produce an oscillator reaction, which is amplified by the Reaction Amplifier, each time the oscillator frequency sweeps by the loop frequency. But the reaction cannot by itself identify the loop, since all the train loops produce a reaction at some point in the oscillator swing. What we have to do, in addition, is to determine the frequency at which the reaction occurs. This problem is solved by feeding the oscillator output not only to the Reaction Amplifier, but also to the circuits represented by the blocks marked Tuned Circuit F1, Tuned Circuit F2, Tuned Circuit F3, and Tuned Circuit F4. Each of these circuits is arranged to produce a momentary output pulse each time the oscillator sweeps by the corresponding frequency. This gives us a means for identifying each train loop; the simultaneous occurrence of an oscillator reaction plus the appearance of an output from the Tuned Circuit which corresponds to the loop frequency. To utilize this information, we make use of a group of thyratron tubes, (which are really just a kind of electronic switch) identified as Thyratron 1, Thyratron 2, Thyratron 3, and Thyratron 4, each of which controls an associated relay. To all of these thyratrons in parallel we feed the pulses produced by the Reaction Amplifier every time an oscillator reaction occurs. In addition, we feed each thyratron, individually, with the pulses developed by its associated Tuned Circuit. Moreover, we arrange our thyratron circuits so that each tube

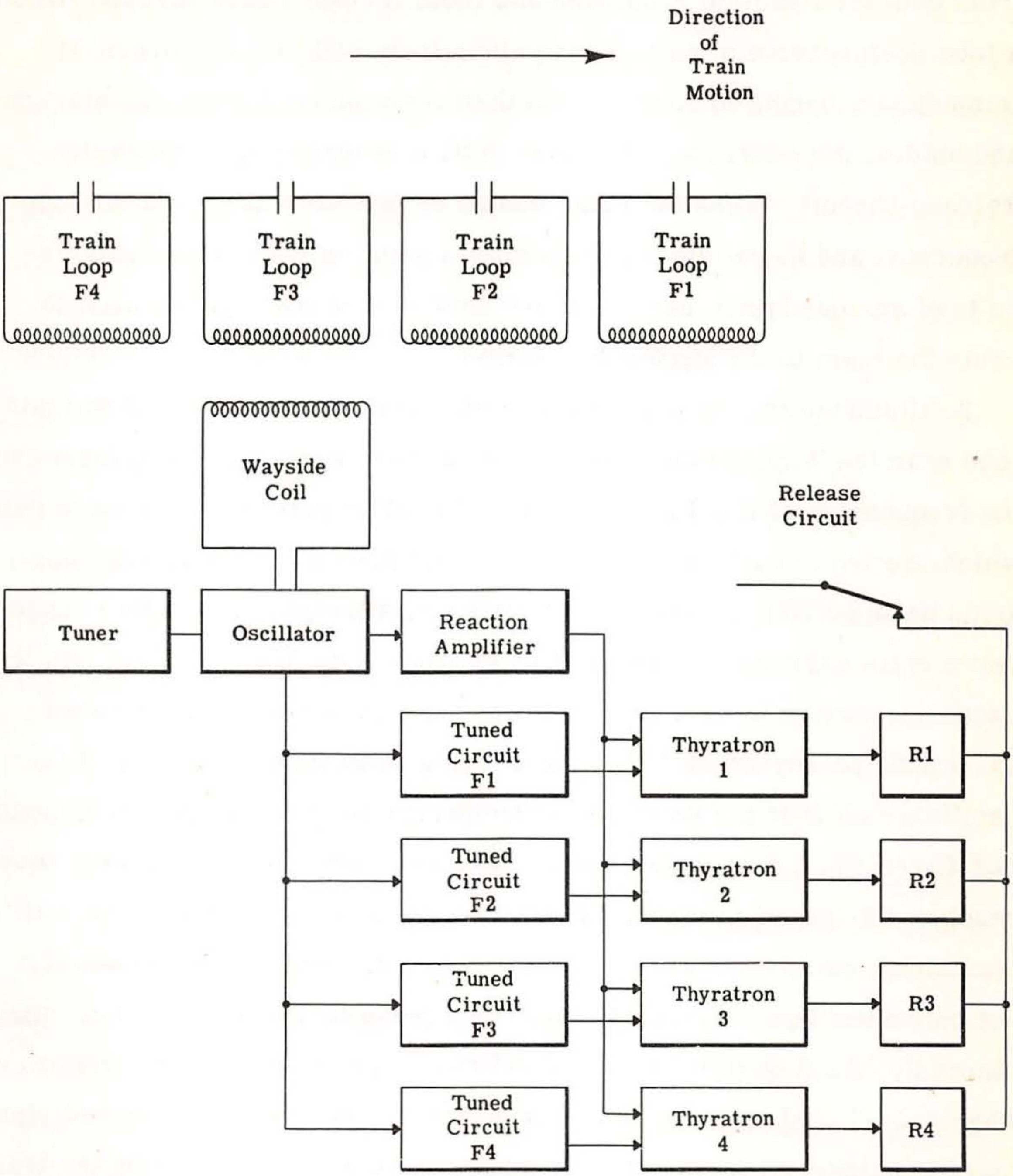

Direction of Train Motion
Train Loop F4
Train Loop F3
Train Loop F2
Train Loop F1
Wayside Coil
Release Circuit
Tuner
Oscillator
Reaction Amplifier
Tuned Circuit F1
Tuned Circuit F2
Tuned Circuit F3
Tuned Circuit F4
Thyratron 1
Thyratron 2
Thyratron 3
Thyratron 4
R1
R2
R3
R4

Figure 3. Organization of automatic train identification and routing system.

remains cut off (non-conducting) until it receives simultaneous pulses from both the Reaction Amplifier and from its own Tuned Circuit. When a tube does receive simultaneous pulses from both these sources, it immediately begins to conduct, and then remains conducting, picking up and holding the corresponding relay until it is turned off through the Release Circuit. When the relay comes up, we have identified the loop frequency, and hence the train; from this point on route alinement circuits of various types, such as those employed in NX, may be used to route the train to its proper destination.

To illustrate the action, consider the situation when there is no train loop near the Wayside Coil. As the oscillator sweeps back and forth over the frequencies of the Tuned Circuits, the latter produce a series of pulses which are fed to each thyratron in turn, but none of the thyratrons conducts because none receives a simultaneous reaction pulse. Now suppose that a train carrying a loop tuned to F3 passes the Wayside Coil. As the oscillator swings by frequency F1, an output pulse is fed from Tuned Circuit F1 to Thyratron 1, but since Train Loop F3 does not affect the oscillator while it is oscillating at frequency F1, no reaction pulse occurs, and Thyratron 1 does not conduct. Similarly, when the oscillator frequency reaches F2, Tuned Circuit F2 delivers a pulse to Thyratron 2, but still no oscillator reaction occurs. When the frequency reaches F3, however, not only does Tuned Circuit F3 deliver a pulse to Thyratron 3, but, simultaneously, the Reaction Amplifier delivers a pulse to all four thyratrons. Thyratron 3 (and only Thyratron 3) therefore receives the required simultaneous pulses, so it conducts and picks up relay R3, identifying the train and setting in operation the circuits which line up the route required for trains carrying F3 loops. As the oscillator continues its swing, it leaves F3 and moves on to F4, but now it has again moved out of the reaction range, so Thyratron 4 receives only the single pulse from its tuned circuit and does not conduct.

It should be pointed out here, without going into detail, that the Reaction Amplifier produces an output pulse only from sufficiently sharp dips in oscillator output. So although stray metallic objects near the Wayside Coil or the passage of steel cars, wheels, etc. may affect the oscillator level, they do not produce the sharp dip characteristic of a tuned train loop, and hence do not cause the Reaction Amplifier to produce spurious output pulses.

We can readily see how a four-frequency system like the one described can identify four different trains. Actually, it can do a lot better than that, because we are free to use combinations of frequencies. We can put not only one, but two, or even three, loops on a single train, and so pick up more than one of the identification relays at a time. As a result, a four-frequency system may be used to identify 14* trains, as follows:

Train Identification Number	Train Loops Carried	Train Identification Number	Train Loops Carried
1	F1	8	F2, F3
2	F2	9	F2, F4
3	F3	10	F3, F4
4	F4	11	F1, F2, F3
5	F1, F2	12	F1, F2, F4
6	F1, F3	13	F1, F3, F4
7	F1, F4	14	F2, F3, F4

We can also combine the train identification features of the system with route-storage circuits, so that we can allow a number of trains to pass the wayside coil location, store the identification information, and then feed it out to the route selection circuits as each train reaches the first switch in the interlocking plant. The circuits can also be arranged to actuate a wayside annunciator so that the engineman can see that his train has been correctly identified and can check that he will be properly routed.

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*A possible fifteenth combination, F1, F2, F3, F4, is not used since this condition - all relays energized - might conceivably result from system failure.

Some of the more important features and advantages of the new system are summarized below.

1. Train loops are simple, economical assemblies requiring no energy. Train identities may readily be changed by exchange of loops.
2. Only one oscillator and one wayside coil are required for any practical number of frequencies. Use of sweep-frequency principle eliminates need for separate oscillators for each frequency.
3. Sweep-frequency operation eliminates need for oscillator stability required with any fixed-oscillator system. All frequency-identifying circuits are passive resonant circuits, inherently stable.
4. By use of approach-control, energy requirements and wear of motor-driven tuner are limited to periods when trains are in identification zone.
5. The system is sensitive only to tuned train loops, and is completely unaffected by even large metallic masses, such as steel cars, wheels, etc.

* * *

Location of cTc Control Machines

Of recent years the trend has been to place cTc control machines at division headquarters, even though the controlled territory does not begin at the same point. The following is a list of G-R-S installations giving location of the control machine and distance to the nearest controlled location.

RR	cTc LIMITS	CONTROL OFFICE	MILES TO NEAREST CONTROLLED LOCATION	TRACK-MILES CONTROLLED
D&H	Schenevus to Delanson, N.Y.	Oneonta, N.Y.	15	93.5
CNR	Truro to Windsor Jct., N.S.	Halifax, N.S.	16	49.6
B&O	Charlestown, Ohio	Newton Falls, Ohio	6	6
Alton	Plainview to Rinaker, Ill.	Brighton, Ill.	13	8
L&N	Henderson to Strawberry, Ky.	Evansville, Ind.	13	137.5
NP	Helena to Garrison, Mont.	Missoula, Mont.	68	51
C&NW	W. Chicago to Nelson, Ill.	Chicago, Ill.	30	141
L&N	Henderson, Ky. to Amqui, Tenn.	Evansville, Ind.	13	144
MP	Middle Brook to Mill Spring, Mo.	Poplar Bluff, Mo.	31	5.5
AGS	Burstall, Ala. to Meridian, Miss.	Birmingham, Ala.	12	137
B&O	Rosemont to Jackson, W. Va.	Grafton, W. Va.	11	81.2

In compiling the above data we have disregarded all installations where the distance between the control office and the nearest controlled location is 5 miles or less.

* * *

GENERAL RAILWAY SIGNAL COMPANY

ORDERING INFORMATION

Ordering information for the Model 10 electric switch lock can be found on Page 29 of Development Sheet D62.1001. When ordering the lock with tandem arrangement specify whether it will be an entirely new installation or added to an existing Model 10 lock layout.

* * *

We are at present preparing a development sheet on the Model 10 lock with tandem arrangement, to be distributed to signal engineers and signal supervisors. An instruction sheet on how to install this accessory to existing locks is being prepared and will accompany each shipment.

GENERAL RAILWAY SIGNAL COMPANY

G-R-S NEWS
February 1951

SYNCROSTEP

For high-speed coded remote control

Syncrostep is a recently developed system that is now available for controlling a single remote location or group such as an interlocking. It is being installed for the first time at Fort Plain, N. Y., on the New York Central.

The principle of operation is the same as that being used in installations of our equipment at several airports, which has proved successful for nearly a year and employs as much as 200 miles of teletype line. This has been called "Mechanical Interlocks" by the C.A.A.

Syncrostep stresses simplicity and speed of operation. It requires a single pair of line wires between the control office and the field location and can be operated either simplex or duplex. In duplex operation, controls and indications may be transmitted simultaneously, being handled by two entirely independent relay systems so that their operations interfere in no way. Controls use a d-c. line circuit and indications use carrier current superimposed thereon; if desired, a third line wire may be used in lieu of carrier.

In simplex operation, one relay system handles both controls and indications. One transmission takes place at a time, controls having superiority, and carrier control is not required.

The speed of Syncrostep is considerably faster than the usual coded system. A control is executed approximately one second after the lever is moved; an indication is transmitted in approximately two seconds. A still faster operation is available that approximately doubles these speeds.

Because of the principle of operation, the system features simplicity. There are no timing circuits--the message, or code, is created simply by the presence or absence of line current in the various steps. A single makeup of Type A relays is used throughout for coding. This type is quick-acting with no special timing features. The line relay is our Type VX.

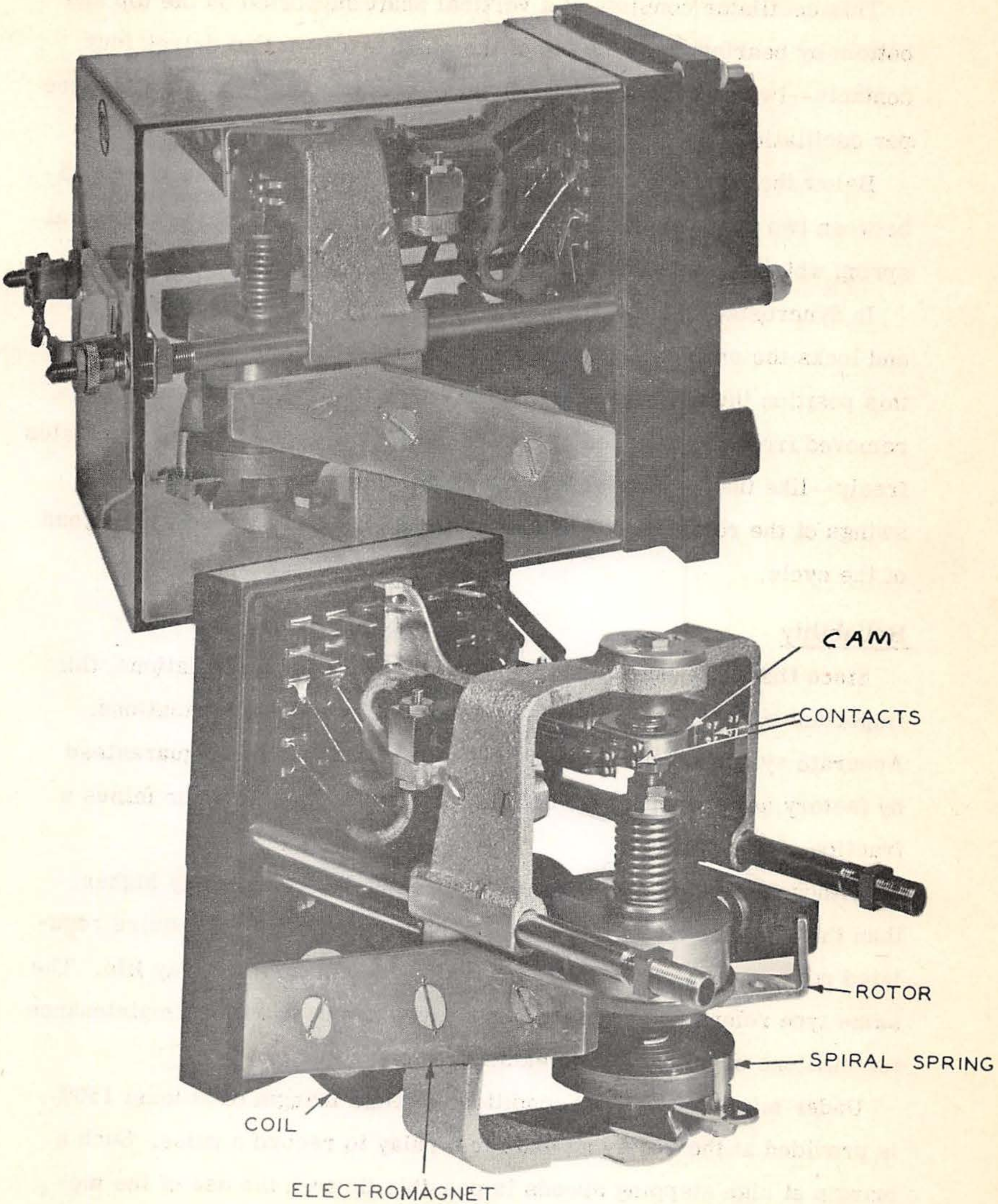
Comparison to Other Coded Systems

Syncrostep employs a principle of operation that is different from that used by any other coded system used in signaling practice. These older types are all "driven" code systems, that is, the stepping relays in the receiving station are driven, or stepped, by a chain of current pulses transmitted by the control office during the cycle. The stepping relays count the pulses and make it possible for other relays to record the information carried by them. This may be in the form of long or short pulses, as in the Type K cTc System or in the form of positive or negative pulses, as in the Type F System. In either case, the line circuit must carry the chain of pulses required to keep the field station in step with the control office, in addition to conveying the intelligence borne by the code.

With Syncrostep there is no driving code. The system operates on what, in teletype practice, is commonly referred to as the start-stop principle. The line circuit is normally energized while the system is at rest. The line is opened by the control office to indicate to the field that the cycle is starting. At the end of the cycle the line circuit is again closed to indicate that the message has been completed. Between these start and stop conditions the two ends of the system are kept in synchronism by means of free oscillations of closely synchronized mechanical oscillators, one of which is located at each end of the line. This permits full use of the line for message purposes.

The Heart of the System

The timing device used for synchronization is a modification of our oscillating code transmitter to provide a "torsional pendulum".


CAM
CONTACTS
ROTOR
SPIRAL SPRING
COIL
ELECTROMAGNET

Mechanical oscillator.

This oscillator consists of a vertical shaft supported on the top and bottom by bearings. At the top of the shaft is a cam that drives four contacts--two on each side. Each set of contacts opens and closes once per oscillation.

Below the cam is a balance wheel and a U-shaped armature located between two poles of an electromagnet. Below the armature is a spiral spring which creates the oscillations.

In Syncrostep, the electromagnet is normally energized by the coil and locks the armature against a stop, preventing it from turning. In this position the spiral spring is held under tension. When energy is removed from the coil, the armature is released and the rotor oscillates freely--like the balance wheel of a watch. Stepping relays count the swings of the rotor and cause energy to be applied to the coil at the end of the cycle.

Reliability

Since timing is based upon these free, mechanical oscillations, this important part of the system is not affected by voltage fluctuations. Accurate synchronization of the office and field is further guaranteed by factory adjustment of the oscillation rate to within plus or minus a fraction of one percent.

Although the stepping speed of Syncrostep is considerably higher than that of other coded systems, the high speed does not require regulated power supplies nor is it obtained at the expense of relay life. The same type relays are employed that have been used with no maintenance for millions of operations in existing cTc systems.

Under minimum voltage conditions, a time margin of at least 150% is provided at the receiving end for a relay to record a pulse. Such a margin at high stepping speeds is possible through the use of the mechanical oscillators. These have an inherent means of distinguishing successive steps of the system so that it is not necessary to operate half-step relays between steps (such as the VP relay in the Type K system which controls the pickup of the step relays so they pick up in an orderly progression). The "off" period need be only sufficient to take care of line distortion, and, therefore, maximum time per step is available to provide the best operating margin during the periods when the code is being recorded.

Operation

The block diagram illustrates the sequence of operation of the various functions when either a control or an indication is transmitted.

The message is the code that is created by permanent connections and is assigned to a particular function at the receiving end.

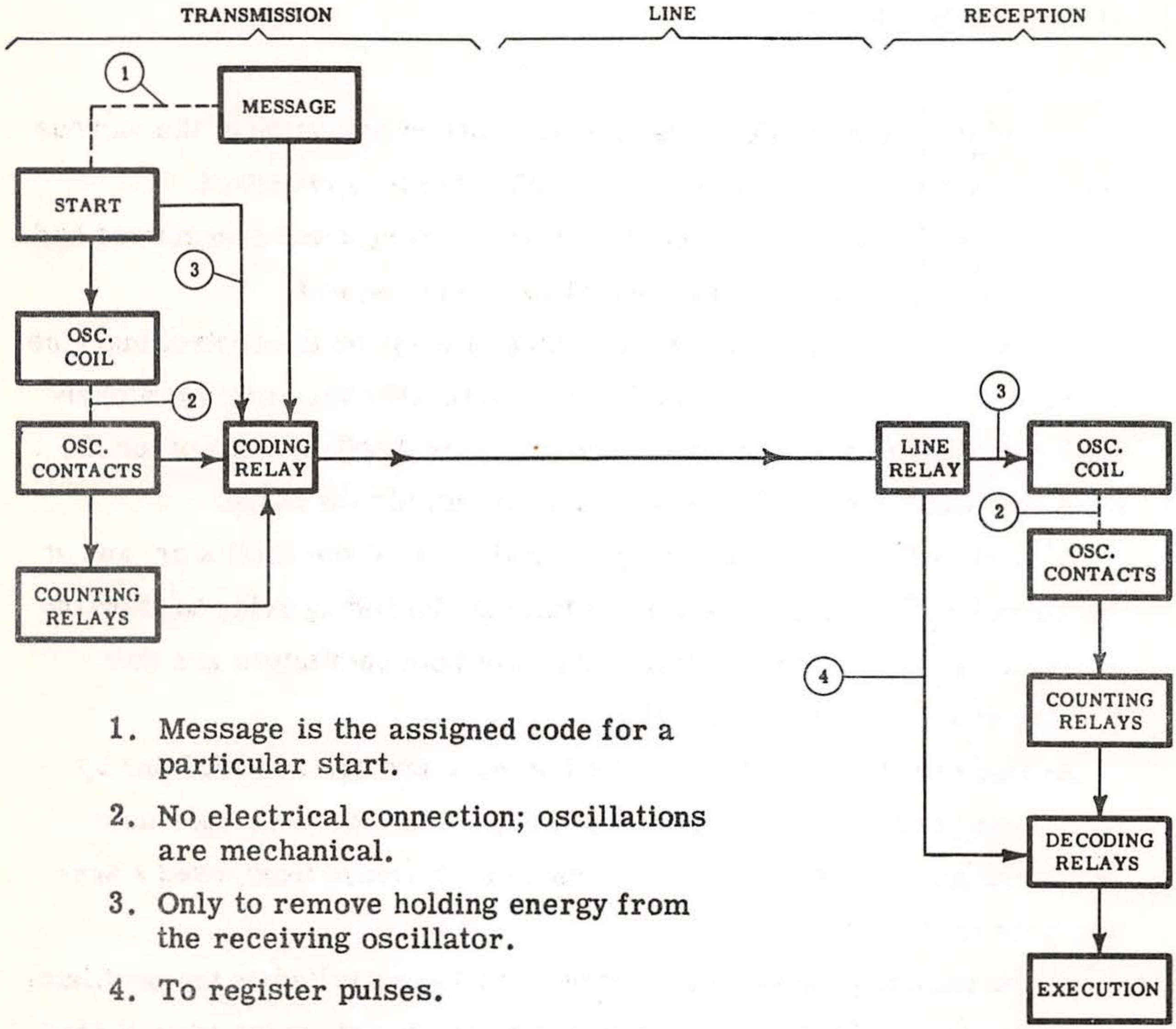
A control is started when, for example, a lever on the control machine is turned to operate a switch in the field; then when the switch has operated, the indication is started back to the control office. Except for the code employed, both transmissions are essentially the same.

A start removes holding energy from the coil of the oscillator, and at the same time opens the line circuit through the coding relay to start the oscillator at the other end. The contacts of both oscillators are then opening and closing in synchronism.

As this occurs, the counting relays at each end are released one by one, these relays being picked up normally. The four counting relays define the seven steps of the code, some of the relays being used a second time for this purpose.

At the transmitting end, the coding relay is controlled by the oscillator contacts combined with the counting relays which determine when it should operate, and the message which determines how it should operate, that is, if the line should be energized or not in a particular step. The line relay follows the operation of the coding relay.

Each time the line is energized, the pulse is registered at the receiving end by the pickup of a decoding relay. If the pulses occur at the proper time, as determined by the counting relays, the code is complete and the control (or the indication) is executed.


TRANSMISSION
LINE
RECEPTION
1
MESSAGE
START
3
OSC. COIL
2
OSC. CONTACTS
CODING RELAY
COUNTING RELAYS
3
LINE RELAY
OSC. COIL
2
OSC. CONTACTS
4
COUNTING RELAYS
DECODING RELAYS
EXECUTION

1. Message is the assigned code for a particular start.
2. No electrical connection; oscillations are mechanical.
3. Only to remove holding energy from the receiving oscillator.
4. To register pulses.

Block diagram showing operation of Syncrostep.

Controls

A control requires a cycle of seven steps on each of which either a "Mark" or a "Space" may be transmitted--the line is energized on a Mark and opened on a Space.

To guard against clearing a signal for a wrong route, a switch-correspondence check network is provided at the control office. This is practicable because of the use of automatic starts (a control is initiated when a lever is turned--there are no start pushbuttons). The signal control is stored at the control office until the route is complete in the field, at which time the signal control is transmitted automatically.

1. Simplex operation

Simplex operation means the line is used for one transmission at a time. Controls have superiority over indications. Regarding the seven steps of the cycle (see code table), the character in the first step signifies whether the cycle is for a control or an indication; a Mark is usually used for a control cycle, as shown in the typical code table. The next five steps are used in combination to give a total of 32 codes. A single control using one of these codes is transmitted each control cycle.

The seventh step is used to check the integrity of the code. The character transmitted in this step depends upon the number of Marks sent in the preceding five steps. Either a Mark or a Space is transmitted in the seventh step to make the total number of Marks, in the last six steps, come out odd. A double error, therefore, would be required to cause reception and execution of an improper code.

The code table is shown only to illustrate the makeup of the codes. Any one of the codes could be used for either a switch or signal control, maintainer's call, snow melters, etc.

CODE NO.	STEPS							
	1	2	3	4	5	6	7	
	CONT. OR IND.	MESSAGE					CH'K	
1	M	M	M	M	M	M	S	2-position function
2	M	M	M	M	M	S	M	
3	M	M	M	M	S	M	M	
4	M	M	M	M	S	S	S	
5	M	M	M	S	M	M	M	
6	M	M	M	S	M	S	S	
7	M	M	M	S	S	M	S	
8	M	M	M	S	S	S	M	
9	M	M	S	M	M	M	M	
10	M	M	S	M	M	S	S	
11	M	M	S	M	S	M	S	
12	M	M	S	M	S	S	M	
13	M	M	S	S	M	M	S	
14	M	M	S	S	M	S	M	
15	M	M	S	S	S	M	M	
16	M	M	S	S	S	S	S	
17	M	S	M	M	M	M	M	
18	M	S	M	M	M	S	S	
19	M	S	M	M	S	M	S	
20	M	S	M	M	S	S	M	
21	M	S	M	S	M	M	S	
22	M	S	M	S	M	S	M	
23	M	S	M	S	S	M	M	
24	M	S	M	S	S	S	S	
25	M	S	S	M	M	M	S	
26	M	S	S	M	M	S	M	
27	M	S	S	M	S	M	M	
28	M	S	S	M	S	S	S	
29	M	S	S	S	M	M	M	
30	M	S	S	S	M	S	S	
31	M	S	S	S	S	M	S	
32	M	S	S	S	S	S	M	

Typical control code allocation for simplex operation.

2. Duplex operation

In duplex operation, a control and an indication may be transmitted at the same time, since two independent relay systems are used, indications being transmitted by carrier.

The first six steps of the cycle are used to give a total of 56 usable codes. As in the case of simplex operation, the seventh step is used only for checking purposes.

Indications

In large interlockings, many more indications are required than can be transmitted during one 7-step cycle. Therefore the indication system employs a cycle of fourteen steps obtained by two consecutive operations of a 7-step cycle similar to that used for controls. As in other cTc systems, all indications associated with one station are scanned in one indication cycle.

1. Simplex operation

As mentioned previously, the first step is used to signify the kind of cycle, in this case being a Space for an indication cycle. The second step is unassigned and is used to obtain proper operating characteristics. The next three steps are usually used for indication station selection (a station is a group of indications). The remaining nine steps are available for indications from that particular station.

2. Duplex operation

In duplex operation, the indications are transmitted by means of carrier currents superimposed on the same d-c. line used for controls. Therefore, all fourteen steps are available for indication purposes. The first three steps of the initial seven are used for station selection. The next four steps of the first group and all of the second, making a total of eleven, are for indications for that station.

New Type Designation

Syncrostep systems have been assigned type designations as follows:

Type A1, Size 7.9, Class S (special for airports)
Type A2, Size 7.16, Class S (duplex)
Type A3, Size 7.9, Class S (simplex)
Type A4, Size 7.9, Class S (duplex)

Type A1 is the original system used in Mechanical Interlocks for airports.

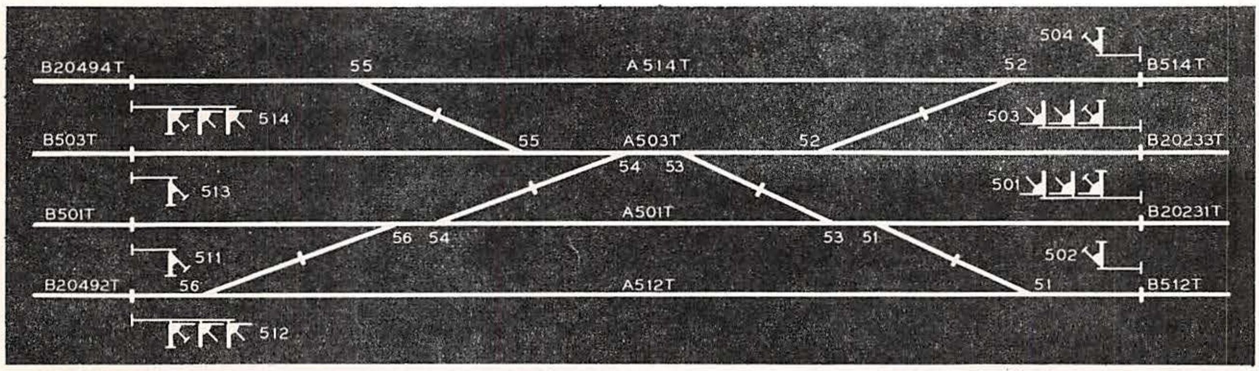
Type A2 is that being installed at the Fort Plain, N. Y. interlocking on the N. Y. C.

The size designation means the number of steps (7), and the speed of a particular system (9 steps per second, or 16 steps per second).

Class S means the system is for a single location.

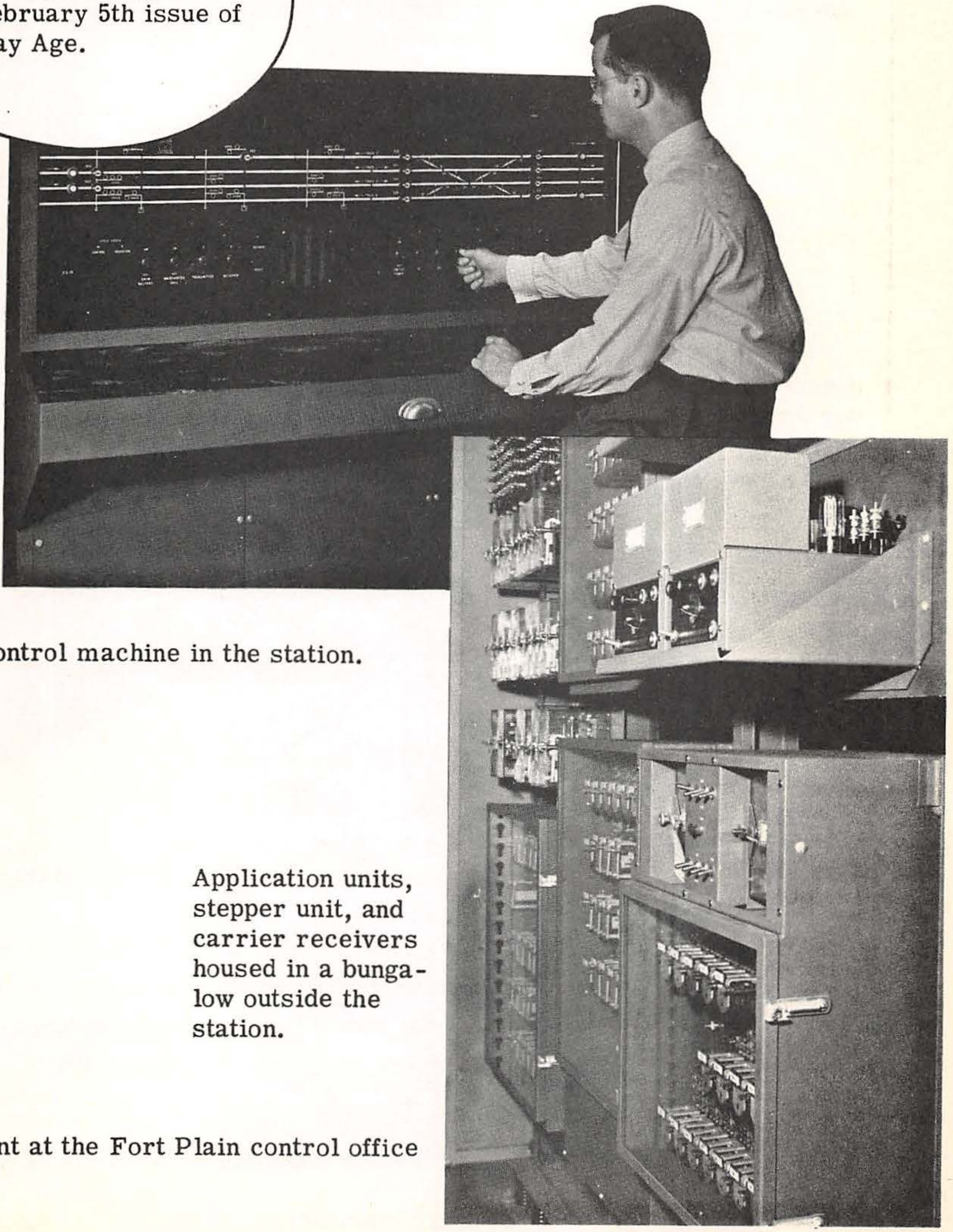
Simplex means controls and indications use the same relay system so that only one transmission can take place at a time. Controls have superiority.

Duplex means controls and indications are transmitted independently of each other. Both may be on the line at the same time, indications using carrier.


504
B20494T
55
A514T
52
B514T
514
503
B503T
55
A503T
52
B20233T
54
53
513
501
B501T
A501T
B20231T
56
54
53
51
511
502
B20492T
56
A512T
51
B512T
512

This is the track layout of the interlocking at Fort Plain, N. Y. on the New York Central. It is the first installation of Syncrostep on a railroad--a duplex system with 42 controls for switches, signals, maintainer's call, snow melters, etc., and 40 indications using superimposed carrier.

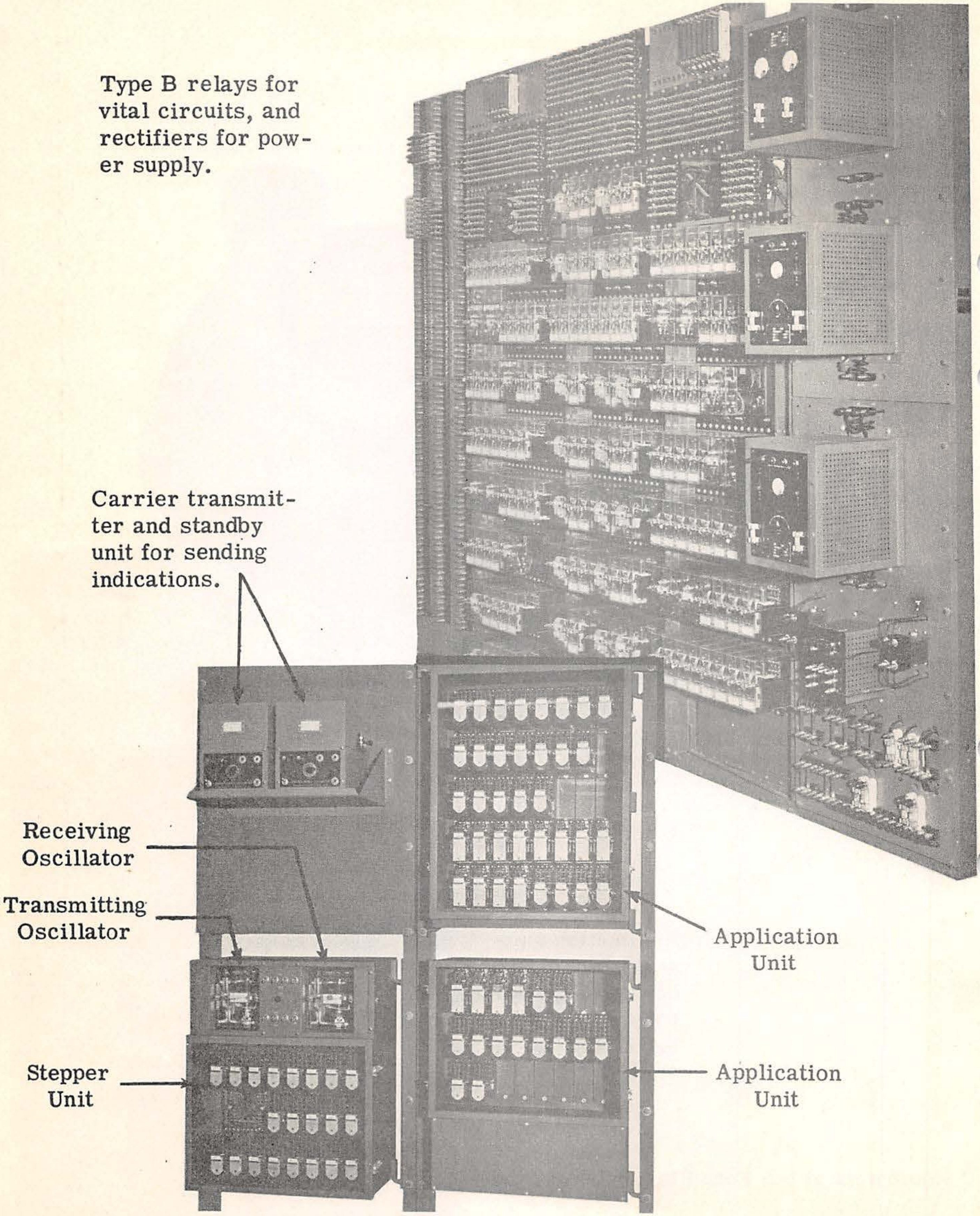
The first advertisement on Syncrostep will appear in the February 5th issue of Railway Age.



Control machine in the station.

Application units, stepper unit, and carrier receivers housed in a bungalow outside the station.

Equipment at the Fort Plain control office


Type B relays for vital circuits, and rectifiers for power supply.
Carrier transmitter and standby unit for sending indications.
Receiving Oscillator
Transmitting Oscillator
Stepper Unit
Application Unit
Application Unit

Equipment at the Fort Plain field location.

G-R-S NEWS
January 1951

CONFIDENTIAL

The information in this issue is of a confidential nature. It has been prepared to provide our sales organization with data on a new G-R-S development, the coded cab signal system that works with d-c. or a-c. coded track circuits. This information is timely since the first advertisement on the new system appears on the back cover of Railway Age, January 8, 1951.

————*

NEW CODED CAB SIGNAL SYSTEM

G-R-S has developed a coded cab signal system which operates interchangeably over coded track circuits energized with direct current, 60-cycle alternating current, or half-wave rectified a.c. A single locomotive equipment responds to all these types of coded energy without requiring any switching.

The new system provides all the well-known benefits of cab signaling, plus these extra advantages:

1. Locomotives can operate with full cab-signal protection over routes in which both a-c. and d-c. coded track circuits are used. Since no switching of locomotive equipment is required, it is not necessary for the engineman to know the type of coded track circuit energy employed in different portions of the route. Locomotives may also be placed in operating pools without having to distinguish among them on the basis of the track energy they are designed to work with.
2. Railroads already using d-c. coded track circuits to control wayside signals can now utilize the same coding to control cab signals.

3. The equipment provides high rejection of the effects of foreign currents which may occur in the rails. This permits the use of coded 60-cycle energy in the track circuits, eliminating the need for conversion equipment to obtain special frequencies, such as 100-cycle. The equipment will detect and respond to code pulses of 60-cycle energy even when foreign 60-cycle currents ten times as great as the code currents are flowing in the tracks.
4. By using coded d-c. track circuits fed by primary battery, cab signaling can be extended to areas where a-c. energy is not readily obtainable. The older cab signal systems, which operated only on a-c. track codes, were usually not practicable for such service because of the a-c. conversion equipment required.

Wayside Arrangement

The wayside circuits required for the new cab signal system can be varied to meet requirements. In general, they are arranged to feed each track circuit with a code which is associated with a particular block condition. These codes are on-off pulses of track circuit energy, usually repeated (for four-indication signaling) 180, 120 and 75 times a minute, with the 180-rate corresponding to the "clear" (green) aspect, the 120-rate to "approach medium" (yellow/green), and the 75-rate to "approach" (yellow). No code, the result of a train shunt in the same block, or loss of code for any reason, produces the "stop" (red) aspect.

This arrangement is essentially the same as that described in our Bulletin 171 for the older cab signal system. If you go back to that publication, you will find, however, that the bulletin description is based on the use of a.c. in the track circuit, with the further proviso that it is customary to employ 100-cycle a.c. in order to avoid interference from 25-cycle and 60-cycle foreign current. The new system, however, can be adapted to practically all types of coded track arrangements, irrespective of the kind of code energy employed, and without regard to whether the wayside code transmitter is of the motor-driven or oscillating type. Moreover, because of the ability of the locomotive equipment to distinguish code pulses despite the presence of substantial interference from foreign currents and stray magnetic fields, dependable operation may be obtained on long track circuits even under low ballast resistance conditions.

Locomotive Arrangement

Before discussing the operating principles of the new locomotive equipment, it will be helpful to review the operation of the older cab signal system. Figure 1 shows the organization of the older system for a steam locomotive, operating with a three-block, four-aspect arrangement using track circuits energized with 100-cycle alternating current coded at 180, 120, and 75 rate - i.e., the 100-cycle a-c. energy is pulsed on and off in the track circuit the indicated number of times each minute.

The two receivers shown in the upper part of the illustration are coils carried on the locomotive, in front of the leading wheels, about six inches

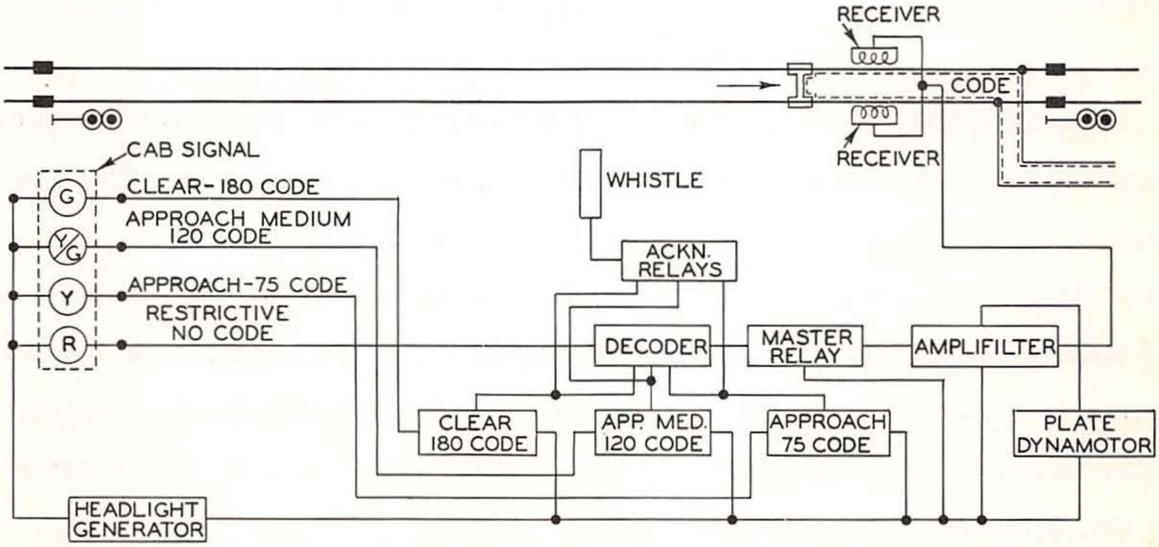

RECEIVER
CODE
RECEIVER
CAB SIGNAL
G
Y/G
Y
R
CLEAR-180 CODE
APPROACH MEDIUM 120 CODE
APPROACH-75 CODE
RESTRICTIVE NO CODE
WHISTLE
ACKN. RELAYS
DECODER
MASTER RELAY
AMPLIFILTER
PLATE DYNAMOTOR
CLEAR 180 CODE
APP. MED. 120 CODE
APPROACH 75 CODE
HEADLIGHT GENERATOR

Figure 1. Organization diagram, cab signal system for 100-cycle a-c. coded track.

above the rail heads. When the 100-cycle a-c. code currents appear in the track, corresponding 100-cycle voltages are induced in these receivers. These voltages are fed to the amplifilter, which is tuned to respond strongly to the 100-cycle frequency, and to reject other frequencies. The amplifilter is a vacuum-tube amplifier which amplifies this 100-cycle energy and then rectifies the amplified a.c. The rectified output is fed to the master relay, which pulses at the same rate as the track codes, since it is energized during the intervals when 100-cycle energy exists in the track circuit, and deenergized during the intervals when the 100-cycle energy is not present. The pulsing rate of the master relay is converted, through a master transformer and tuned circuits, into controls for the relays which govern the aspect displayed on the cab signal - green for 180 rate, yellow/green for 120 rate, yellow for 75 rate and red for no code. The details on how this is accomplished are given in Bulletin 171.

To provide an audible warning in addition to the visual display of the cab signal, a whistle is included which sounds every time a more restricting aspect change occurs on the signal. This continues to blow until silenced by the engineman's operation of a manual acknowledging contactor.

Figure 2 shows the organization of the new system, providing the same four-aspect operation on a modern diesel-electric locomotive. The new system is, of course, not limited to this type of locomotive. You will note that this is practically identical with Figure 1, with three exceptions - (1) a motor-generator suitable for operation from the locomotive's local supply is substituted for the dynamotor previously used; (2) the master relay is not shown separately; (3) the "amplifilter" section is replaced by an "amplifier" section.

The first of the foregoing differences arises from the different nature of the power supply available on diesel-electric locomotives. The second, the omission of the master relay, is to make allowance for the fact that two different decoding arrangements have been developed for the new system, one of which does not use this relay, while the other does. In the latter case, the code-following master relay may be considered as included in the "decoder" section of the organization diagram. The third change listed above - the substitution of a new amplifier for the old amplifilter - is the important element which permits the use of the same locomotive equipment with both a-c. and d-c. coded track currents.

Unlike the old amplifilter, which amplified the 100-cycle code pulse in the rails and produced a d-c. output during the entire time each code pulse existed, the new amplifier is arranged to respond only to certain transient effects which occur whenever a code pulse begins and ends. These transient effects are largely independent of the nature of the energy in the code pulse, and appear whether the pulse is d.c., 60-cycle a.c., or half-wave rectified 60-cycle a.c. Every time the beginning (leading edge) of a code pulse appears in the track, the transient pulse picked up by the receivers is amplified and used to produce an output pulse from the amplifier. When the code pulse disappears from the track, the last portion of the pulse (trailing edge) produces another transient effect which is again amplified to produce an output pulse from the amplifier. Thus the amplifier produces two output pulses for each code pulse, one marking the beginning of the code pulse, the other marking the end of the code pulse. During the interval between the leading and trailing edges of a single track pulse the amplifier produces no output, since the abrupt transients to which the amplifier responds do not occur.

The "decoder" section of the organization diagram, Figure 2, represents the means by which the amplifier output pulses are converted into signal controls. This may be done in either of two ways, both of which produce the same over-all results.

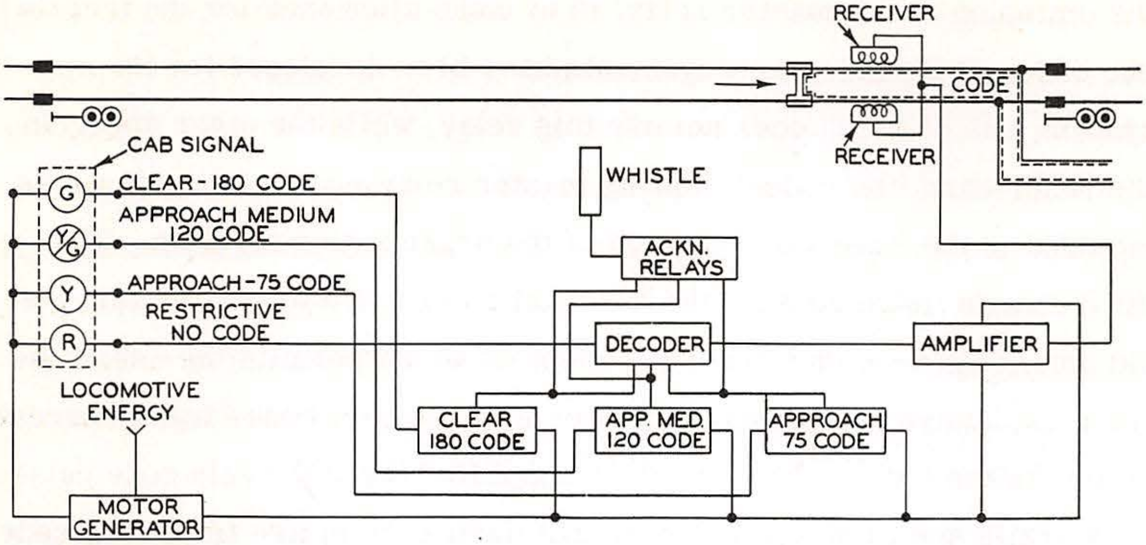

RECEIVER
CODE
RECEIVER
CAB SIGNAL
G
CLEAR - 180 CODE
Y/G
APPROACH MEDIUM 120 CODE
Y
APPROACH - 75 CODE
R
RESTRICTIVE NO CODE
WHISTLE
ACKN. RELAYS
DECODER
AMPLIFIER
LOCOMOTIVE ENERGY
CLEAR 180 CODE
APP. MED. 120 CODE
APPROACH 75 CODE
MOTOR GENERATOR

Figure 2. Organization diagram, cab signal system for a-c./d-c. coded track.

The first method is by use of a polar master relay controlled through an electronic switch which reverses the polarity of its output (and hence reverses the relay) each time an electric pulse is fed to it. When the pulse output of the amplifier is fed to this electronic switch, the relay reverses its position for each pulse from the amplifier, completing an over-and-back cycle for each pair of amplifier pulses. Since each track code pulse produces a pair of amplifier output pulses (leading and trailing edges), the relay follows the track code. The organization of the decoding circuits from this point on is similar to that of the older cab signal system.

The second method of decoding, and a new approach to the problem, is by use of a "code rate discriminator" which is completely electronic in operation, and which does not use tuned circuits to distinguish among code rates. Briefly, this discriminator consists of three electronic timing channels designed to respond, respectively, to pulses separated by 1/3, 1/2, and 4/5 of a second, corresponding, again respectively, to

180, 120, and 75 code rates. When any one of these channels receives three consecutive pulses separated by the time interval for which the channel is designed, that channel produces an output which energizes a corresponding rate relay. The latter, in turn, controls circuits which produce the desired signal aspects. The code rate discriminator operates on either the leading-edge output or trailing-edge output of the amplifier, depending upon which is first received in each block, and ignores the intermediate pulses produced by the amplifier from the other edge of the track code.

The cab signaling developments described above are of particular importance at the present time, in view of the order which the I.C.C. has issued requiring the use of continuous cab signals, train stop, or train control equipment (or a combination of these) on lines where trains operate at speeds in excess of 79 miles per hour. The new system, by virtue of its universal response and high discrimination against foreign currents, makes feasible the application of cab signaling to railroads which could not use the older system because of technical and economic considerations.

* * *

GENERAL RAILWAY SIGNAL COMPANY

G-R-S NEWS
April 1948

Model 8 Switch Circuit Controller

A new circuit controller, designated the Model 8, has been developed. Several test models have been tried on various railroads and the results have been satisfactory. We understand that the Model 8 should be in production by July.

THE FOLLOWING WRITEUP IS ISSUED FOR YOUR INFORMATION ONLY. RELEASE FOR SALES WILL FOLLOW.

* * *

The Model 8 is similar in some respects to the Model 7. There are certain changes, however, which insure longer life and better operation. We will explain these changes in detail in this issue.

I. THE CASE

In Figure 1 you will note that the complete case has not been changed appreciably. The front mounting holes, in accordance with A.A.R. Sig. Spec. 95-44, Part 49, are now on 5-inch instead of 4-inch centers. The heavy and durable arch construction of the case is, of course, still a predominant feature. The cover gaskets completely seal the case from weather; the terminal compartment is sealed from the mechanism section by a gasket in the cover bridge. Wire openings are provided on both sides of the case. Overall height is 6-15/16 inches.

II. THE CAMS

The cam assembly, Figure 2, while providing the same simple adjustment principle, is now of heavier construction due to the fact that the cam shaft has been increased in diameter from 1 inch to 1-1/2 inches (A.A.R. Sig. Spec.). The larger shaft provides added rigidity

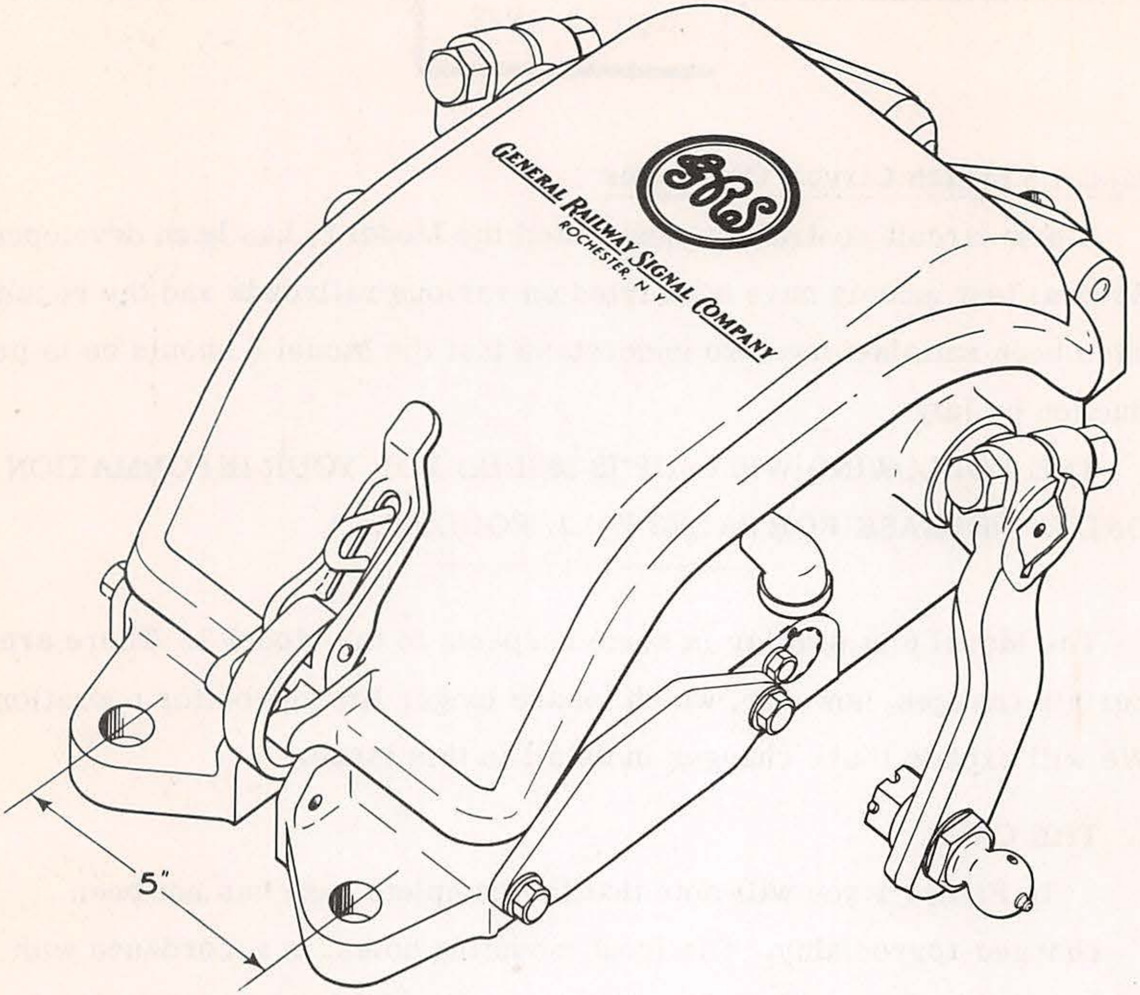


Figure 1. The Model 8 switch circuit controller.

to insure positive contact with the rocker arm face, Figure 3. A cold drawn steel insert on the face of the cam results in a durable contacting surface. This face, as well as the contact surface on the rocker arm, has been increased in width to one inch.

The cams force and hold the contacts in all positions mechanically. The cam adjustment will take care of switches having from 3-1/2 to 5-1/2 inches of throw.

III. THE ROCKER ARM AND CONTACT FINGER

The rocker arm and contact finger assembly of the new Model 8 is shown in Figure 3. For easy reference and as a comparison we

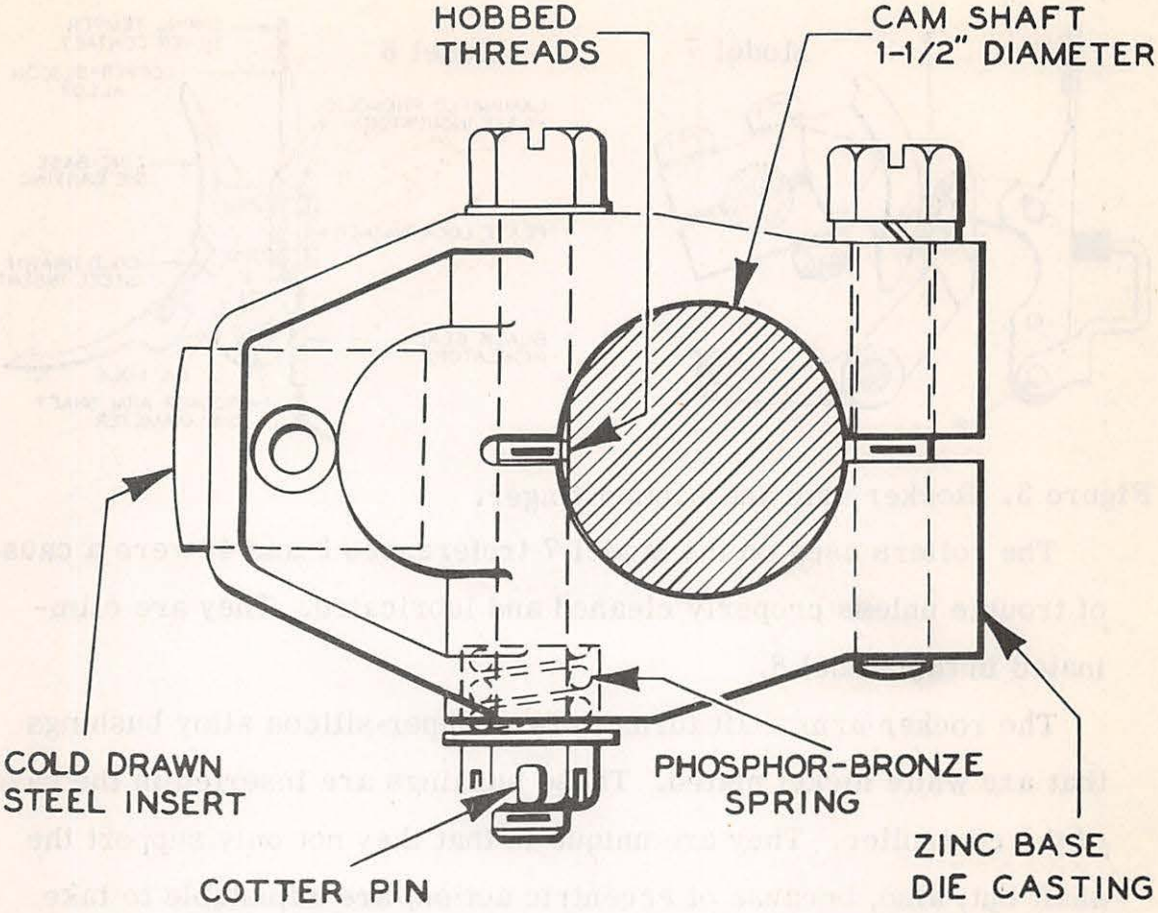

HOBBED THREADS
CAM SHAFT 1-1/2" DIAMETER
COLD DRAWN STEEL INSERT
PHOSPHOR-BRONZE SPRING
ZINC BASE DIE CASTING
COTTER PIN

Figure 2. Cam assembly of Model 8 controller.

have also shown the cam and contact assembly as used in the Model 7. Notice the change in construction. Bearing points 1 and 2 are now replaced by a single rugged rocker arm shaft, the diameter of which is 5/8 inch. This shaft supports the four rocker arms and provides extremely close alignment for the contact fingers. Individual support of the fingers in the old model resulted in greater wear, misalignment, and difficult replacement of parts.

The zinc-base, die-cast rocker arm has a cold drawn steel insert which provides a durable wear surface. The faces of the arm and cam are machined so as to be in perfect alignment. Two oil holes are provided on each rocker arm bearing.

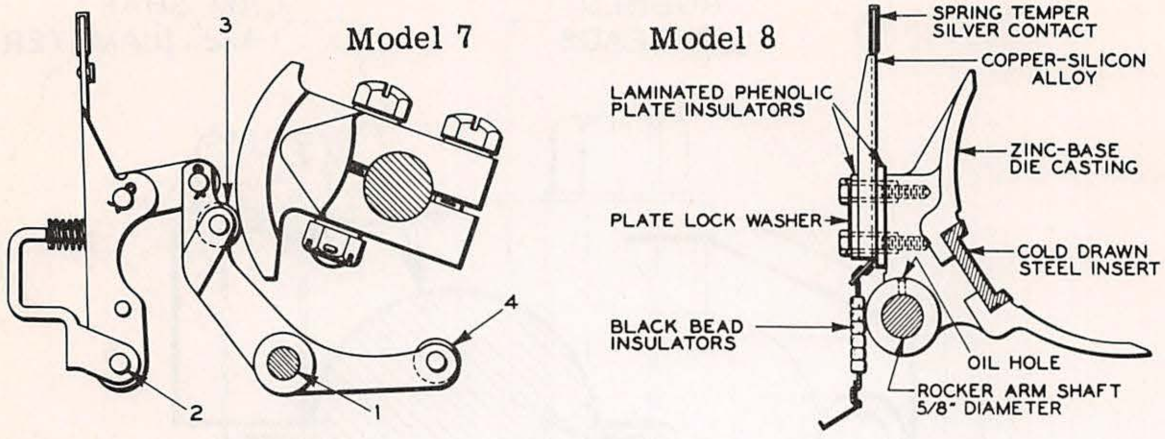

Model 7
3
4
2
1
Model 8
SPRING TEMPER SILVER CONTACT
COPPER-SILICON ALLOY
LAMINATED PHENOLIC PLATE INSULATORS
ZINC-BASE DIE CASTING
PLATE LOCK WASHER
COLD DRAWN STEEL INSERT
BLACK BEAD INSULATORS
OIL HOLE
ROCKER ARM SHAFT 5/8" DIAMETER

Figure 3. Rocker arm and contact finger.

The rollers used on the Model 7 (references 3 and 4) were a cause of trouble unless properly cleaned and lubricated. They are eliminated in the Model 8.

The rocker arm shaft turns in two copper-silicon alloy bushings that are white nickel plated. These bushings are inserted in the case of the controller. They are unique in that they not only support the shaft but, also, because of eccentric action, are adjustable to take up for wear between the rocker arm and cam contacting surfaces.

Figure 4 is a perspective drawing of this bushing. The outside diameter is machined to fit closely in holes drilled in the controller case. The bore in the bushing is made 0.020" ± .003"off center.

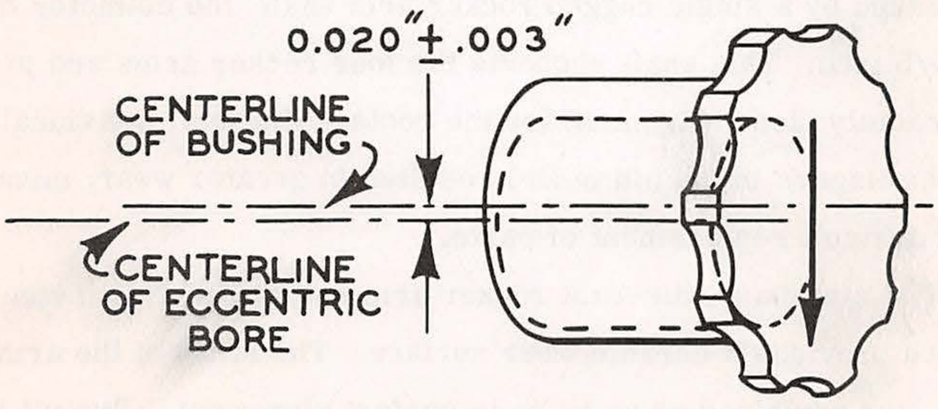

0.020" ± .003"
CENTERLINE OF BUSHING
℄ CENTERLINE OF ECCENTRIC BORE

Figure 4. Adjustable bushing for rocker arm shaft.

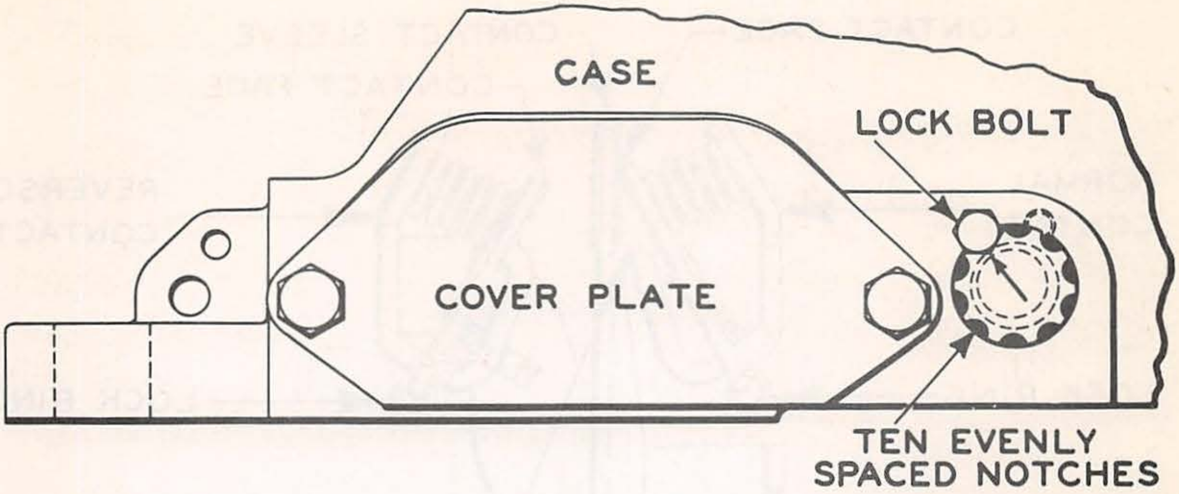


Figure 5. Bushing is held in the case by a lock bolt.

Hence the total adjustment that can be made between the rocker arm and cam surfaces is about 0.040 inch.

Adjustment of the bushing, Figure 5, is accomplished by removing the lock bolt which is threaded into the case of the controller, and fits into one of ten notches that are spaced evenly on the head of the bushing. An arrow stamped on the end of the bushing shows the direction that the hole is off center with respect to the outside surface. When adjustment is made, the arrows on the two bushings are made to point in the same direction to insure even wear of each cam and rocker arm. The bushings are rotated on each end of the rocker arm shaft until proper contact is made between the rocker arm and cam surfaces. The lock bolts are then replaced to hold the bushings in position.

The rocker arm and contact finger, Figure 3, are assembled as a unit. The channel-shaped finger, made of copper-silicon alloy with a silver contact sleeve, is bolted to the rocker arm and spaced with laminated phenolic insulators. The corners of the plate lock washer are formed to the bolt heads, holding them in position after securing the assembly. The usual flexible cable with black bead insulators is used to electrically connect the finger with the terminal board.

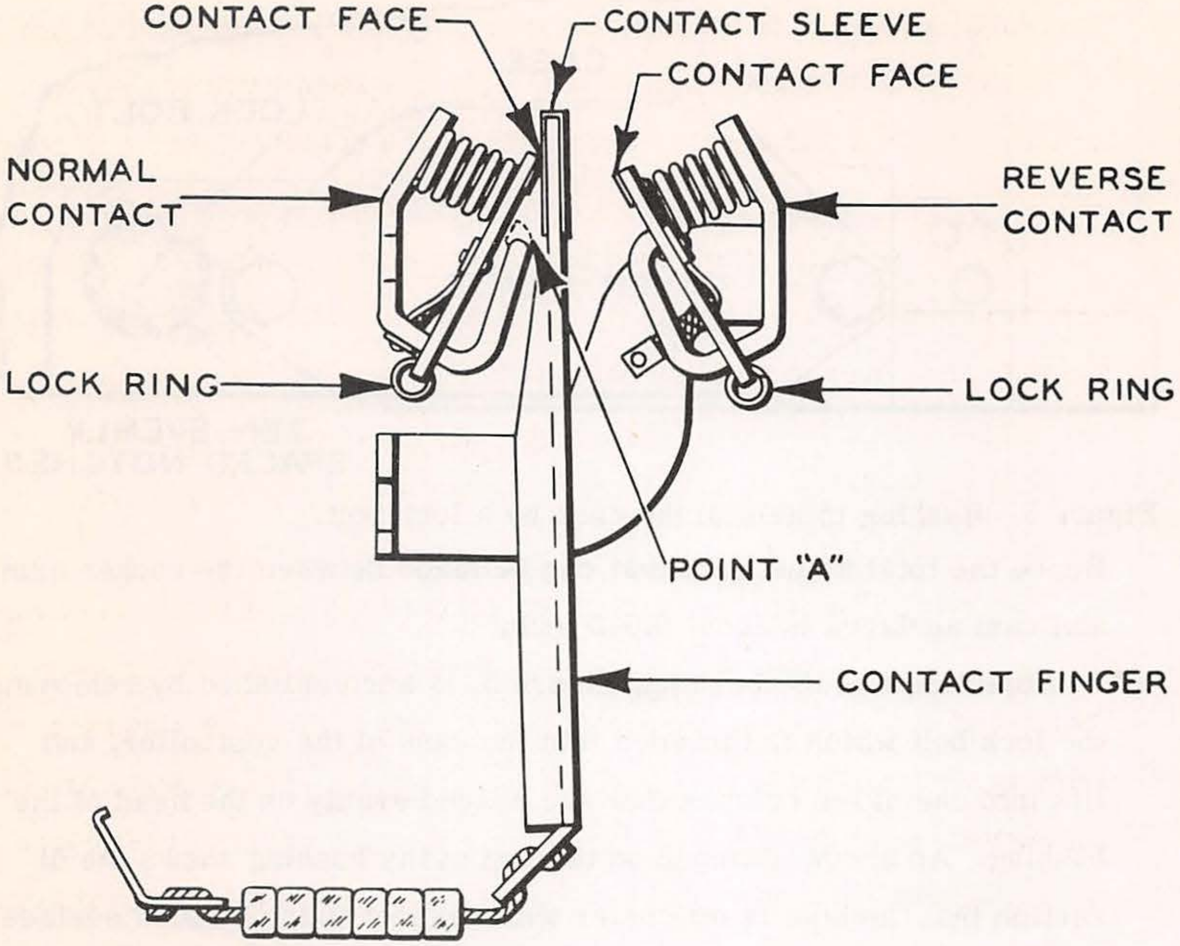

CONTACT FACE
CONTACT SLEEVE
CONTACT FACE
NORMAL CONTACT
REVERSE CONTACT
LOCK RING
LOCK RING
POINT "A"
CONTACT FINGER

Figure 6. Contact assembly.

IV. THE CONTACT ASSEMBLY

The contact assembly, Figure 6, in the Model 8 has been altered to some extent. The normal and reverse contact coil springs, previously made of phosphor-bronze and exerting a pressure of approximately 4 pounds, are now made of cadmium-plated steel music wire, exerting a pressure of about 6 pounds (A.A.R. Sig. Spec. require 4 lbs.). The turned-in end of the normal contact stop of the Model 7, as represented by dotted lines in the diagram at point A, has been removed to allow greater clearance for the finger contact and longer contact wipe. The contact arms on normal and reverse contacts are now held in place by small lock rings instead of a wire loop as previously used. This feature is for ease in assembly and replacement of worn contacts. The reverse contact assembly has been tipped forward slightly to allow for greater clearance of the contact finger and larger contact wipe.

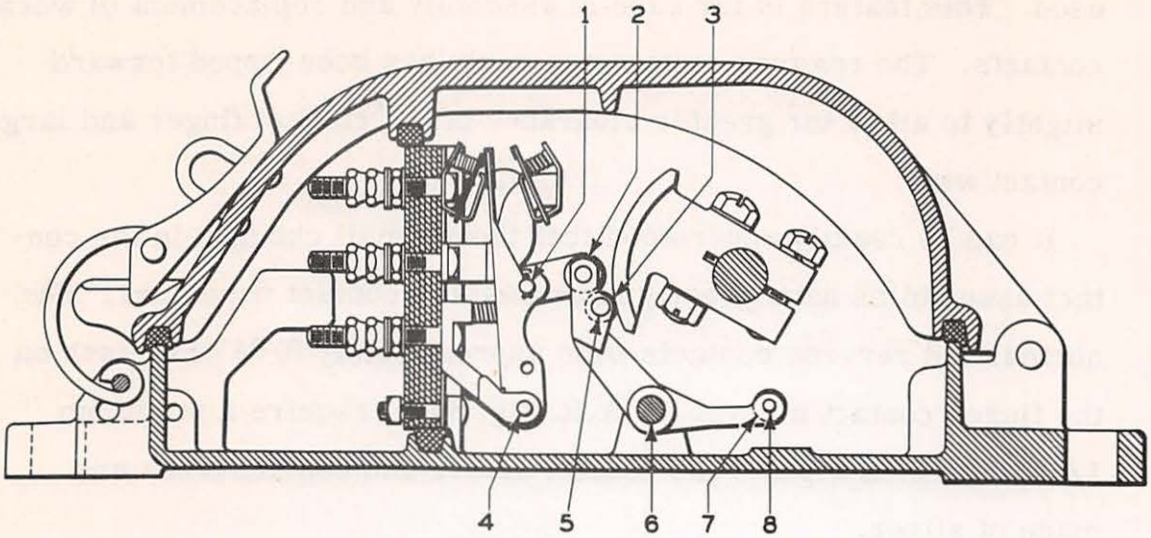
It can be readily understood that these small changes in the contact assemblies have greatly increased the contact wipe area. The normal and reverse contacts wipe approximately 5/64 of an inch on the finger contact sleeve. (A.A.R. Sig. Spec. require a minimum 1/32 of an inch wipe.) The contact sleeve and contact faces are made of silver.

Two ventilating ports, located on opposite sides of the contact fingers, Figure 1, create a draft across these parts, thereby driving out dampness and lessening the corrosive effects of moisture and the frosting or freezing of moisture on the contacts. These ports are of the conventional design, with No. 28 A.W.G. chromium-nickel corrosion resisting steel wire cloth, 30 x 30 mesh, molded in their structure.

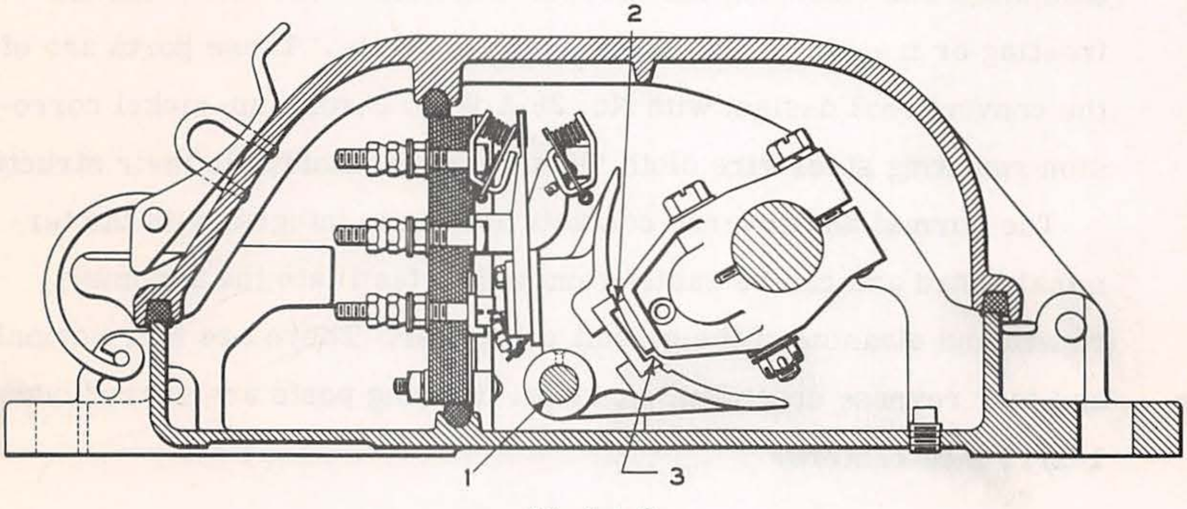
The normal and reverse contacts are made integral with the terminal board and can be easily removed to facilitate the assembly, repair and cleaning of the circuit controller. There are four normal and four reverse dependent contacts. Binding posts are spaced on 1-9/16 inch centers.

V. POINTS OF WEAR

The cross sectional diagrams in Figure 7 are presented to point out the comparison between the bearing and contact surfaces of the two models. Model 7, referring to the numbered arrows, has 8 points of wear, while Model 8 has only 3 points subjected to wear. In addition the bearings and shafts of the new device are larger, therefore distributing the wear over a much larger area. The surfaces sub-



Model 7



Model 8

Figure 7. Wear points.

mitted to the greatest wear, rocker arm to cam, are further protected by the steel inserts.

The length of the cam shaft bushings is 1-9/16 inches. They are made of bearing bronze and are removable. Two pressure lubrication fittings for the cam shaft are inside the controller case, protected from dirt and damage. The bushings have annular grease grooves.

VI. ADVANTAGES

In conclusion and for your ready reference we include the following list of improvements to be found in the Model 8 controller:

1. Case mounting holes now on 5-inch centers (A.A.R. Sig. Spec. 95-44, Part 49).
2. Cam is of heavier construction--has a cold drawn steel insert.
3. Cam shaft diameter is now 1-1/2 inches (A.A.R. Sig. Spec.).
4. Rocker arm is of heavier construction--has a cold drawn steel insert.
5. Rocker arm shaft is larger in diameter and supports all rocker arms in the case.
6. Rocker arm bushing, copper-silicon alloy, provides a simple and accurate means of adjustment.
7. Contact finger arm is anchored to the rocker arm for greater stability.
8. Contact springs are cadmium-plated, steel music wire exerting a greater contact pressure.
9. Refinements in contact assembly allow greater clearance for the finger contact.
10. Lock rings on the normal and reverse contacts allow for greater ease in replacement.
11. The contact wipe has been increased.
12. A number of movable parts subjected to wear have been eliminated.
13. Due to its push-pull construction, the Model 8 operating cams force and hold the contacts in position at all times. (A.A.R. Sig. Spec.) The push-pull mechanism of the Model 7 was an optional feature.

* * *

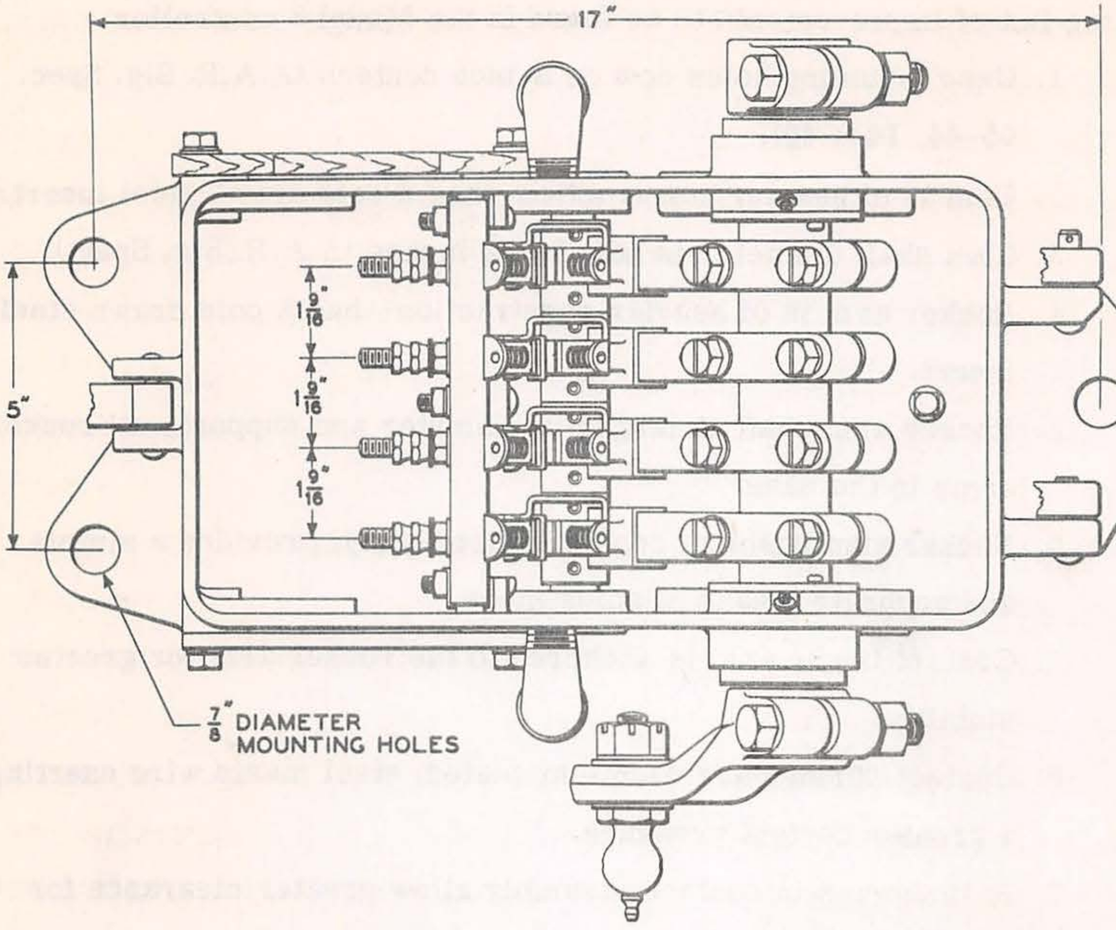

17"
5"
1 9/16"
1 9/16"
1 9/16"
7/8" DIAMETER MOUNTING HOLES

Figure 8. The Model 8 controller has four normal and four reverse dependent contacts. Like parts of the same design and manufacture are interchangeable. The operating crank is provided with an insulated or non-insulated ball stud, as required. Stud is equipped with pressure lubricating fitting.

A Vignette of Signaling History

One day, 20 years ago, a small group of signalmen witnessed a thrilling sight. They saw the first non-stop meet on single track without train orders.

The experience of that day is vividly described in the following portion of a speech given by Mr. J. J. Brinkworth, Vice-President in Charge of Operations, New York Central Lines, West of Buffalo, at the 49th Annual meeting of the A.A.R. Signal Section, in Chicago September 11, 1947.

"Now for centralized traffic control. I saved that for the last because by good fortune I was particularly involved in centralized traffic control in 1927. Some of the men in this room were directly involved in centralized traffic control. I recall distinctly when I went to the Toledo & Ohio Central in 1926 and Messrs. B. J. Schwendt and Oscar Falkenstein started to talk to me about centralized traffic control, I asked, "What are you talking about? I never heard of such a thing." They explained it to me, of course, in considerable detail and I began to understand it, began to see the value of it. I went to Rochester, to the General Railway Signal Company plant, and saw the actual machine there. I, of course, became acquainted with Mr. S. N. Wight of that Company, who studied out the details of the C.T.C. machine. I went to his house and in the back room we talked it over in detail for hours.

"Then we came to 1927, when the final date was set to install centralized traffic control on the Toledo & Ohio Central and put it into service. Needless to say, we were all over at Fostoria, Ohio, and we watched the progress of the various signals being put in along the approximately 40 miles of railroad between Toledo and Berwick. Then, after a comparatively short time, trains started to move over that piece of single track for the first time without train orders.

"I recall very distinctly, as we had supper in the hotel at Fostoria and got through, I said to the gang, "I do not know what you fellows are going to do tonight, but I'm going over to the tower at Fostoria and stay there until I see a non-stop meet." Well, they all decided that if the boss was going over, the rest of the gang had better go, too. So we went over to the tower at Fostoria in the evening. The dispatcher was there and he was just filled up with enthusiasm on this new gadget called centralized traffic control. I said to Charlie Dye: "We are going to stay here if we stay all night until we see a non-stop meet on this machine." Along about 10:00 o'clock, he just yelled right out loud, "Here comes a non-stop meet!" Well, we all gathered around the machine and watched the lights that you know all about, watched the lights come towards each other and pass each other without stopping.

That, to me, and to you, too, was history on American railroads, the first non-stop meet on single track without train orders, of course, that we knew of. We waited at Fostoria until the southbound train arrived there and you never saw such enthusiasm in your life as was in the mind and hearts of that crew, the first non-stop meet of which they had ever heard. Of course, needless to say, it is occurring all over the nation at the present time. The increase in centralized traffic control has been just enormous, thousands of miles of it and thousands being installed at various places from month to month".

* * *

Charlie Dye at the
Fostoria control machine.

G - R - S NEWS
March 1955

In this issue:

Automatic Block Signals
Improved HD Circuit
Index for 1954

G-R-S NEWS
December 1954

In this issue:

Detector Track Circuit.
Tractive-Armature Flasher Relay.
New Sighting Plate and Spring for
Types SA and SC Signals.
Patents.

DETECTOR TRACK CIRCUIT

A new detector track circuit with high shunting sensitivity characteristics has been developed, primarily for use in retarder yards. This circuit will provide detection when the track is occupied by poor shunting cars which fail to drop the track relay.

Description

The new track circuit, Figure 1, uses a conventional battery (5 cells of lead or the equivalent voltage) and a 4-ohm track relay with series resistance, but employs, in addition, an impulse transformer and an impulse relay of the code responsive type. The impulse transformer has three windings: input, compensating, and center-tapped output. The input winding is in series with the feed to the track. The compensating winding is connected across the track at the relay end. The output winding, in conjunction with half-wave rectifiers, operates the impulse relay.

The track (occupancy detector) repeater relay, TPR, is used in yards with automatic switching to provide sufficient contacts for the switching circuits. For yards without automatic switching, this relay can be omitted, and the control can be carried directly to the switch control relays.

Operation

When a car enters the track circuit the shunt, even though it may be intermittent and of high resistance, causes the current in the input winding of the impulse transformer to increase, and the current in the compensating winding to decrease. Since the magnetism produced by the current in the compensating winding opposes that produced by the input winding, these current changes act in the same direction magnetically. The resultant magnetic change produces a voltage in the output winding such that the right-hand terminal, Figure 1, is positive. As a result,

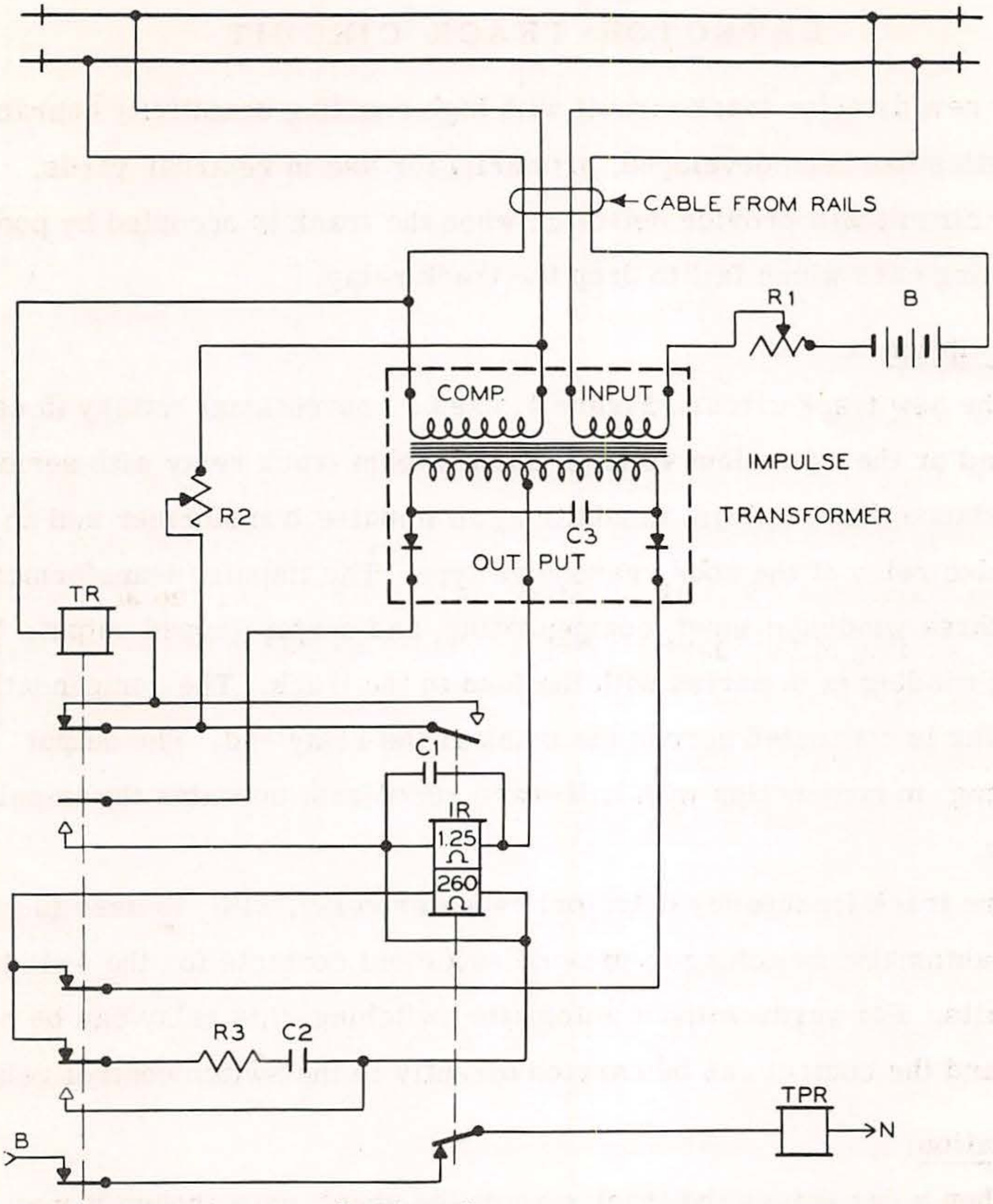

CABLE FROM RAILS
R1
B
COMP.
INPUT
IMPULSE
TRANSFORMER
R2
C3
OUT PUT
TR
C1
IR
1.25 Ω
260 Ω
R3
C2
TPR
B
N

Figure 1. Detector Track Circuit.

current flows from this terminal through the right-hand rectifier, a front on track relay TR, and both coils of impulse relay IR in series, returning to center tap of the output winding. IR picks up, opening the circuit to track repeater relay TPR to indicate track occupancy.

The foregoing describes what occurs immediately after the car occupies the detector track circuit, even though the shunting is very poor.

Note that the operation of IR is interlocked with the operation of TR. If the shunt is good, IR releases immediately after TR drops and the circuit acts as a conventional d-c. track circuit.

However, if the shunting conditions are such that TR does not drop promptly, or if the shunt conditions become so poor that TR can again pick up if once down, IR takes over to provide the occupancy indication and keep the circuit to TPR open. With TR up, shunt variations which occur while the car is moving through the track circuit result in variations in the magnetization of the input and compensating windings. Each time such a variation occurs, IR receives another impulse. With TR up, condenser C2 (with limiting resistor R3) is shunted across the lower winding of IR, making IR slow release so that it holds up between impulses from the impulse transformer. However, if the shunt becomes sufficiently good to release TR, the energy to IR is cut off by means of contacts on TR, and IR immediately drops.

When a car which has dropped TR leaves the track circuit, the magnetic change in the impulse transformer is in the direction to make the left-hand output terminal positive. This picks up IR through the left-hand rectifier, a back contact on TR, and the upper coil of IR returning to the center tap of the output winding. With IR up, TR follows, through an IR front contact. Stored energy in condenser C1 prevents losing IR during the crossover of the TR front contact.

It is not possible to pick up TR, because of the open stick circuit, unless IR comes up to close the pick-up circuit. Pickup of TR therefore checks that IR is operating as intended. With TR again up, the circuit to the upper coil of IR is opened at a back contact of TR, and IR drops to complete the circuit to TPR.

TRACTIVE-ARMATURE FLASHER RELAY

A new flasher relay of the tractive-armature type has been developed for flashing lamps at highway grade crossings. The relay performs the same functions as the motor-operated flasher.

Lamp-control contacts on the tractive-armature relay are so arranged that a contact is always closed under full contact pressure when the relay is deenergized. As a result, a warning will still be provided by a single steady light on each arm should the relay fail to operate.

GENERAL DESCRIPTION

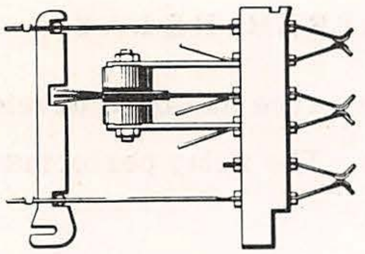
The relay is of the Type B Size 2 design, 5 inches wide, 6-5/16 inches high and 8-3/8 inches deep. It plugs on a standard Type B2 plugboard and has the usual registration feature.

A novel element of the relay is an arrangement of permanent magnets built into the coil-control contacts which provides snap action of these contacts.

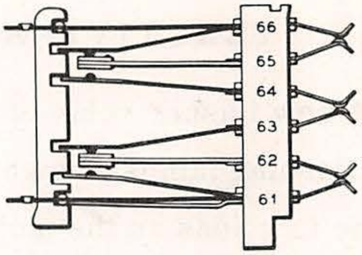
Magnetic Structure

The armature is supported on a horizontal shaft and, when the relay is deenergized, hangs in a vertical position midway between the two core heads, Figure 1. The air gap between the armature and core heads may be varied by stop screws in the core heads to permit adjustment of the flashing rate.

The contact operating arm is fastened to the armature support shaft. Movement of the armature toward one or the other of the core heads causes a corresponding rotation of the support shaft, which in turn moves the operating arm. Movement of the operating arm is transmitted to the contacts by the pushers.

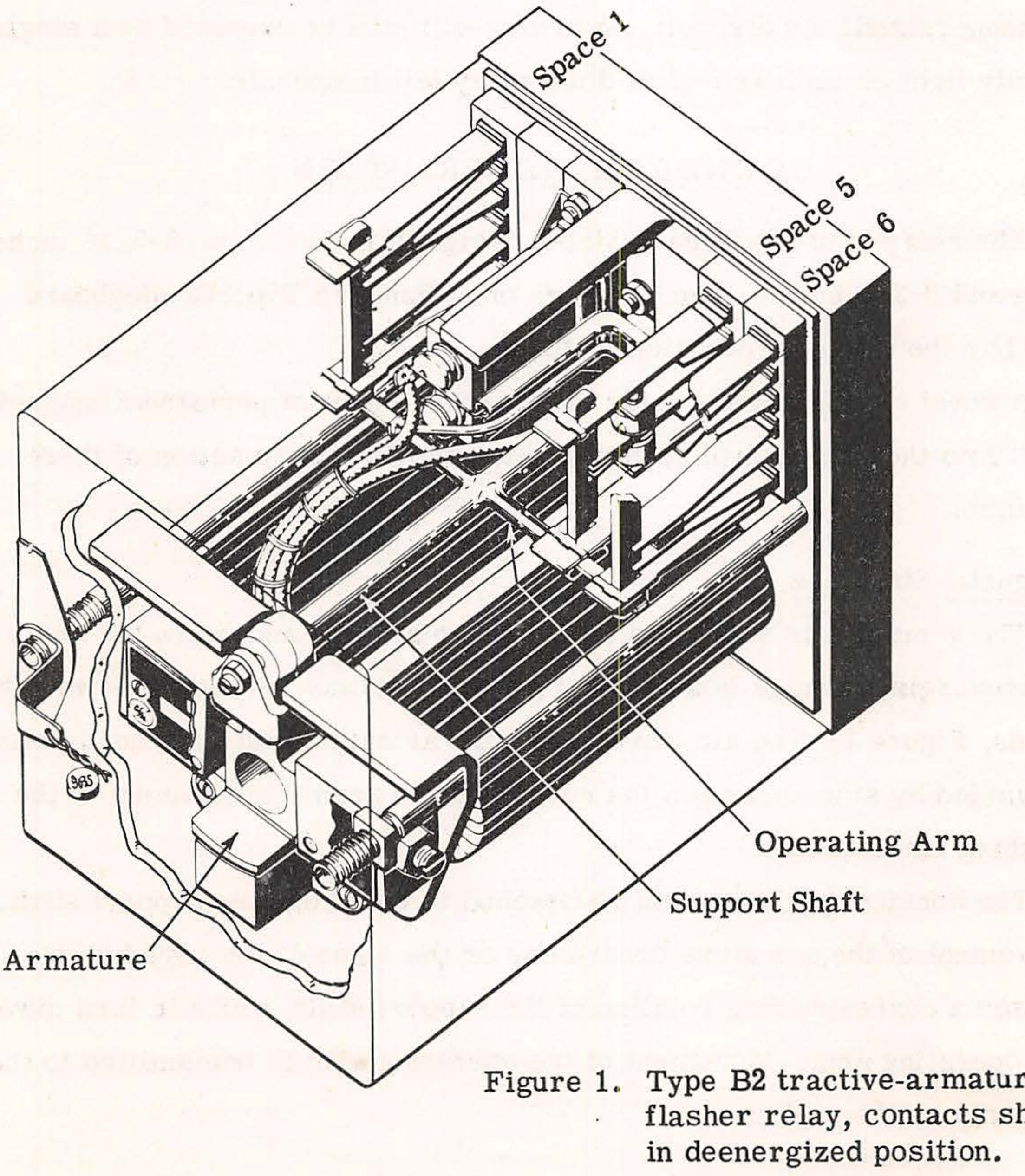


Coil-control contacts



66
65
64
63
62
61

Lamp-control contacts (Space 6)



Space 1
Space 5
Space 6
Operating Arm
Support Shaft
Armature
365

Figure 1. Type B2 tractive-armature flasher relay, contacts shown in deenergized position.

Contact Assemblies

There are four sets of lamp-control contacts and one set of coil-control contacts in the relay. Two sets each of lamp-control contacts are in relay spaces 1 and 6, located symmetrically on either side of the armature support shaft. The coil-control contacts are located in space 5.

Lamp-Control Contacts

The biasing springs for the lamp-control contacts hold the associated pushers down against the operating arm. Since the forces exerted by these springs on the operating arm are balanced, they do not affect the deenergized position of the relay armature.

Lamp-control contacts in spaces 1 and 6 are arranged identically. Considering space 6, contact springs 61, 63 and 64, 66 of the lamp-control contacts are biased against contacts 62 and 65 respectively. That is, they will close against contacts 62 and 65 unless restrained by the pusher. As shown in Figure 1, the pusher slots are so arranged that contacts 62, 63 and 65, 66 are closed and the contacts 61 and 64 are open, when the armature is in the center position. Downward movement of the pusher serves merely to maintain this condition. Upward movement of the pusher, however, opens contacts 63 and 66 and permits contacts 61 and 64 to close.

Coil-Control Contacts

The upper and lower contacts of the coil-control contact group are stationary, Figure 1, while the center contact finger is movable. The upper and lower contacts each carry a cylindrical permanent magnet, attached by a silver screw which is the actual contact element. The center contact finger carries an upper and a lower iron washer fastened to the finger by a silver rivet which projects on either side to form the contact element. The center finger is always against either the upper or lower contact, held by the magnetic attraction between the magnet and iron washer.

The center finger of the coil-control contacts is operated by a pusher slot which engages two resilient extensions on the finger. With the armature in its deenergized position, neither of the resilient extensions is engaged by the slot.

OPERATION

When a train enters the highway crossing control section, lamp-control relay XR, Figure 2, is deenergized. Back contacts on XR apply energy to the coils of the flasher relay, and complete the lamp-energy circuit through contacts on the flasher relay.

Figure 3 shows simplified operating diagrams of the tractive-armature flasher relay. With energy applied to the left coil, Figure 3A, flux begins to flow through the left-hand core, the armature, and copper

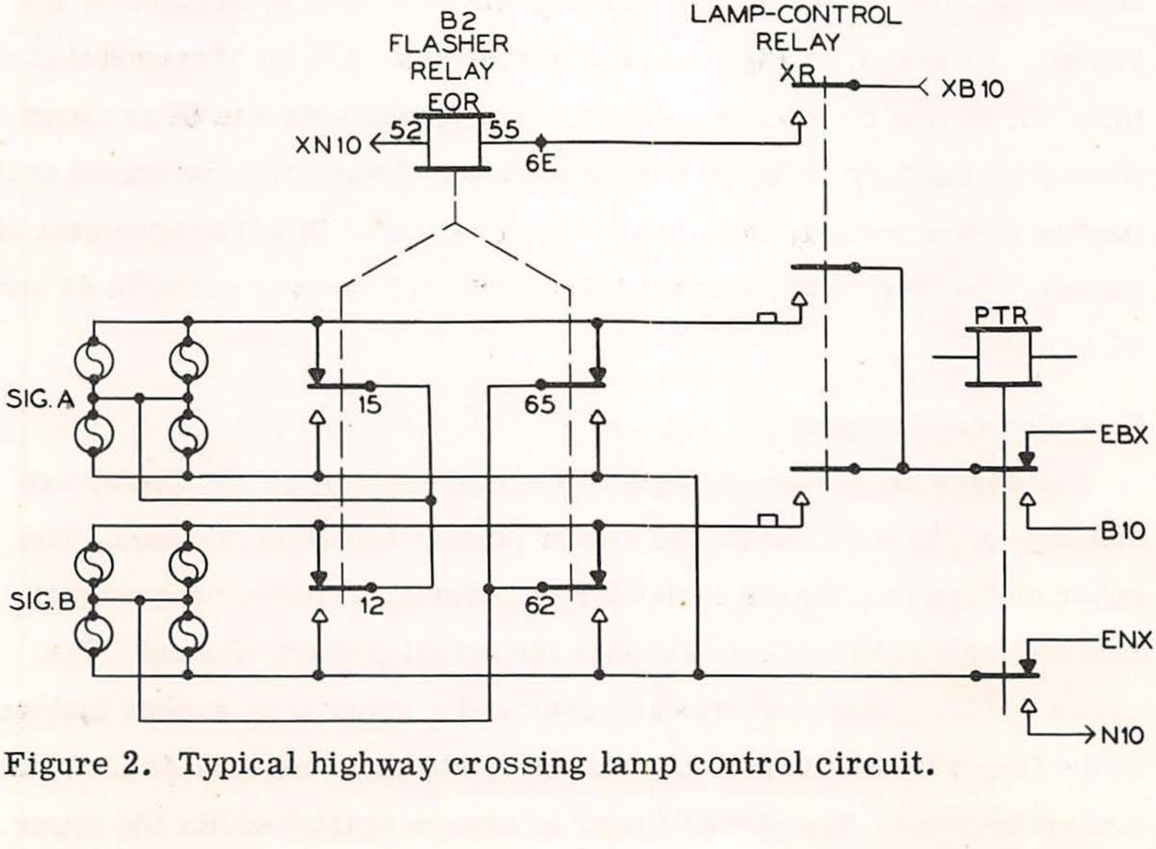

B2
FLASHER
RELAY
EOR
XN10
52
55
6E
LAMP-CONTROL
RELAY
XR
XB10
PTR
SIG. A
15
65
EBX
B10
SIG. B
12
62
ENX
N10

Figure 2. Typical highway crossing lamp control circuit.

slugged core mounted below the armature. This slug retards the build-up of flux and in part establishes the flashing rate of the relay. When sufficient flux is built up, the armature is attracted to the left core head. The contact operating arm, moving with the armature, turns in a clockwise direction to operate the lamp-control contacts and coil-control contacts. The upper lamp-control contacts on the left stay closed to maintain an indication while the lower lamp-control contacts on the right close as shown in Figure 3B. Referring to Figure 2, it can be seen how the flashing lamps are connected in this typical circuit.

The coil-control upper contact magnet, Figure 3A, acting on the iron washer, holds the center contact finger up until the pressure exerted by the pusher on the resilient contact spring reaches a point where it overcomes the attraction of the magnet. The pusher thus forces the center finger with its iron washer into the field of the lower contact magnet. A toggle action results as the center finger snaps down to the lower contact as shown in Figure 3B. Energy is now transferred to the right coil and relay operation is reversed.

INTERNAL WIRING

The internal wiring for the tractive-armature flasher relay is shown in Figure 4. The relay shown is for operation on 10 volts. For 12-volt operation, an internal resistor is provided between fingers 52 and 53 in space 5. The resistor and condenser are used in the relay to provide arc suppression and reduce radio interference.

FLASHING RATE

The flashing rate of the flasher relay is factory adjusted by adjustable stops in the core heads, Figure 1, to between 45 and 50 flashes per minute.

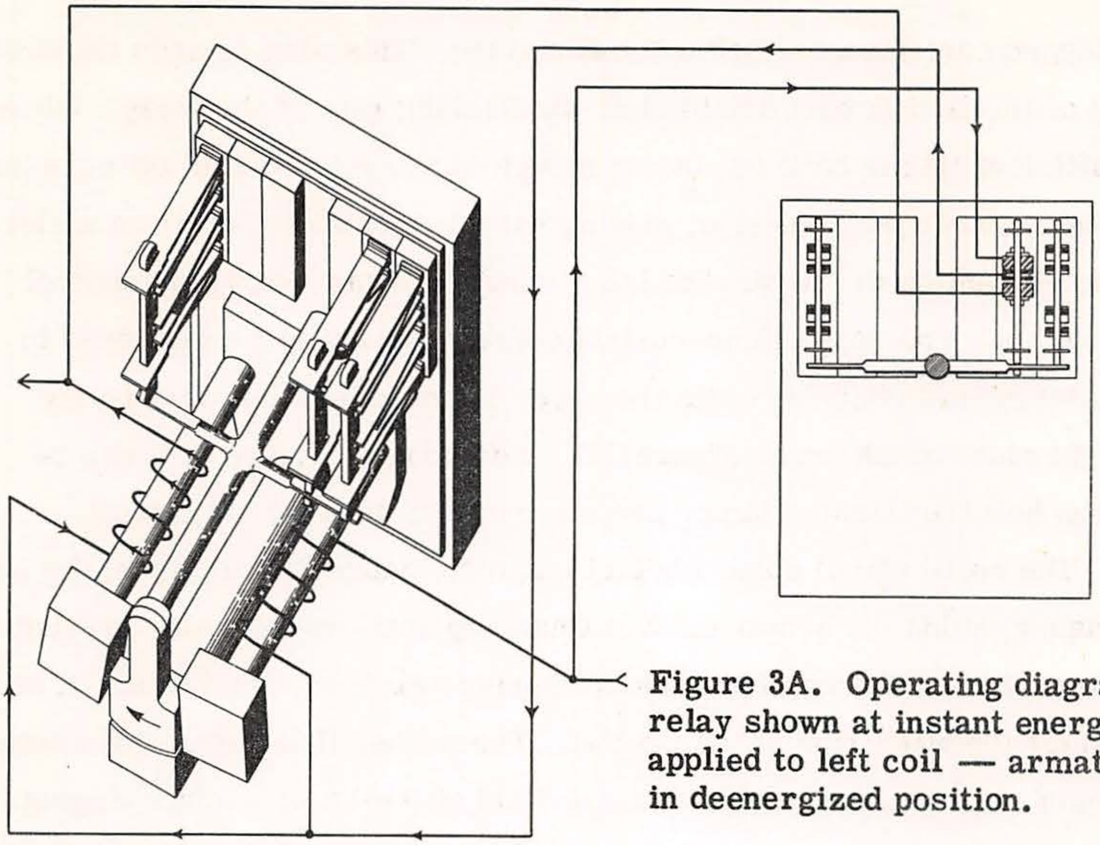


Figure 3A. Operating diagram, relay shown at instant energy is applied to left coil — armature in deenergized position.

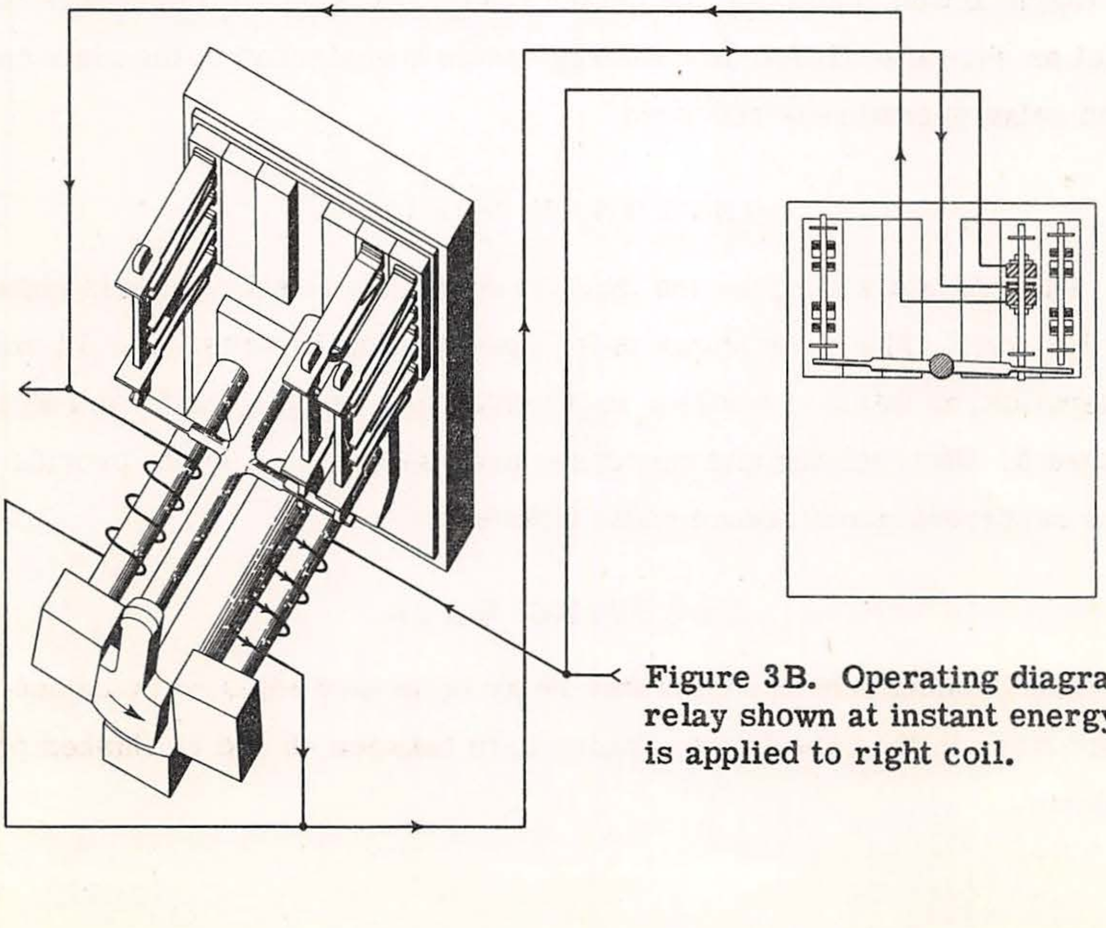
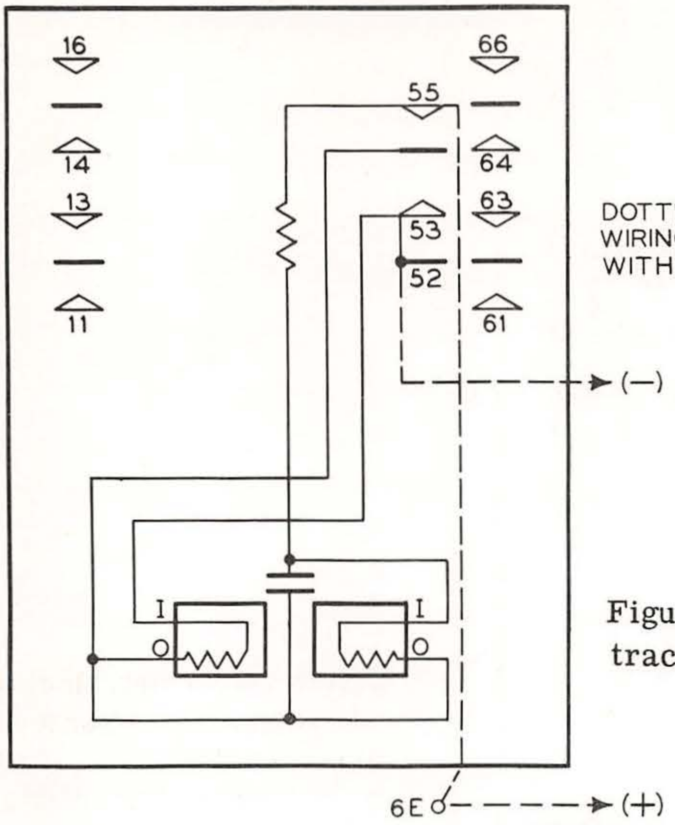


Figure 3B. Operating diagram, relay shown at instant energy is applied to right coil.



DOTTED WIRING IS PLUGBOARD WIRING SOLID WIRING IS WIRING WITHIN THE RELAY

Figure 4. Wiring of a B2 tractive-armature flasher relay.

INSTALLATION

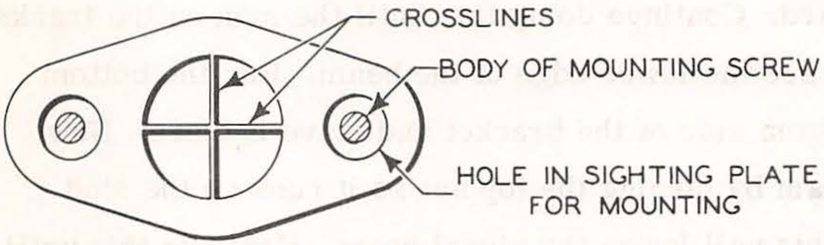
When the relay is installed caution must be exercised to avoid a short circuit through the lamp-control contacts. The contacts in space 1 must never be placed in multiple with the contacts in space 6. Contacts in space 1 can be multipled or contacts in space 6 can be multipled, as the relay is designed to have full contact pressure on all upper contacts when deenergized. In this manner, only one lamp of each pair of lamps will show steady red, should the relay fail to operate.

NEW SIGHTING PLATE AND SPRING FOR SIGHTING DEVICE

Types SA and SC Signals

New Sighting Plate

The new sighting plate, Figure 1, is a one-piece stamping. It does not contain glass or neoprene washers. It is attached to the sighting device at the same position as the sighting plate previously furnished.



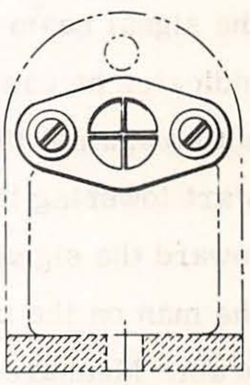


Figure 1. New sighting plate showing clearance around mounting screws.

Field Installation

The sighting plate will be properly positioned on all signals going out from the factory. Replacement in the field requires that the new sighting plate be carefully aligned with the light beam. The sighting plate has large mounting holes and small diameter attachment screws so there is ample room for this field adjustment. Both vertical and horizontal adjustments will have to be checked.

Have a man stand down the track at the approximate point at which the beam center of the signal is aimed. Have him move to the left until he can just see the edge of the beam. He should mark this spot. Then have him move to the right until he can just see the right-hand edge of the beam. He should also mark this spot. Now he can determine, either by actual measurement or by approximation, the halfway point between the two spots previously marked. He should stand on this middle spot and indicate to you on the signal mast that he is in the center of the beam. You should now line up the vertical crossline of the sighting plate on this man. Tighten mounting screws sufficiently to hold this alignment.

While the man stands on this middle spot in the center of the beam, loosen the adjusting nuts on the vertical adjustment stud. Back off the nut underneath the bracket and turn down the top adjusting nut, tilting the signal beam upward. Continue doing this until the man on the tracks indicates he can just see the lower edge of the beam. Run the bottom nut up against the bottom side of the bracket and leave it there. Now start lowering the beam by turning the top nut so it runs up the stud toward the signal. This will lower the signal beam. Continue this until the man on the track indicates he can just see the upper edge of the beam. Measure the distance between the bottom edge of the bracket and the top edge of the bottom nut. Split this distance in half and mark with chalk or pencil the halfway point on the threads of the vertical adjustment stud. Now run the bottom nut up till its top surface is just even with the halfway mark on the threads. Screw down the top nut until both nuts are touching the bracket. Tighten both nuts equally against the bracket at this point without disturbing the adjustment. The horizontal crossline should now be set on the man on the tracks without disturbing the vertical adjustment previously described. Tighten the mounting screws securely. If the adjustments have been carefully made, the sighting plate is now correctly aligned with the beam center of the signal, and you may now aim the signal in the usual manner by sighting through the peephole and lining up the crosslines on the point on which you wish the beam to center.

Spring for Peephole

A specially shaped spring, Figure 2, is now being furnished with sighting devices on Types SA and SC signals. It is inserted in the

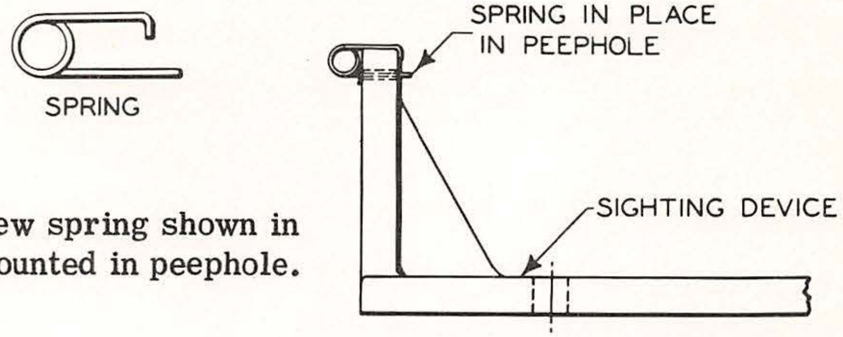

SPRING
SPRING IN PLACE IN PEEPHOLE
SIGHTING DEVICE

Figure 2. New spring shown in detail and mounted in peephole.

peephole as shown in Figure 2. Intended to keep the peephole free of obstruction, the spring should be left in place except, of course, when sighting the signal.

GENERAL RAILWAY SIGNAL COMPANY

PATENTS

The Company wishes to congratulate its employees who have had patents issued to them. Copies of these patents will be furnished by the Patent Department upon request made by the inventors involved and those others who may profitably use printed copies of the patents in connection with the Company's work.

Inventor's Name	Pat. No.	Date	Invention
T. J. Judge	2,668,231	2-2-54	cTc system with coded track circuits normally at rest but initiated in response to a route establishing code.
T. J. Judge	2,671,164	3-2-54	NX system with completion network having a route check for use with coded communication systems.
J. C. O'Brien	2,671,166	3-2-54	Radio communication system.
J. E. Willing R. J. Little	2,678,410	5-11-54	Lightning relief gap for type K relays.
N. B. Coley R. F. Albrighton	2,678,437	5-11-54	Air traffic control system.
R. F. Albrighton	2,679,034	5-18-54	Syncrostep system with code integrity check.
R. J. Little	2,682,586	6-29-54	Heavy duty non-bounce lamp control contact.
R. B. Haner, Jr.	2,682,639	6-29-54	Radio communication apparatus
F. W. Brixner	2,690,238	9-28-54	Automatic control for a car retarder in accordance with speed of an approaching car.
H. C. Kendall F. P. Zaffarano	2,693,525	11-2-54	Electronic train describer inductively acted upon by passing train.

G-R-S NEWS
March 1954

In this issue:

G-R-S Trakode.
Transistors used in Coded Cab Signal Systems.

G-R-S TRAKODE

Principles of Operation

Introduction

G-R-S Trakode is a new signaling development that employs track circuits with polarized energy, pulsating at a relatively slow rate. These track circuits provide a means of controlling wayside signals in both directions without the use of line wires. Hence the system may be applied to control absolute permissive block signaling or the automatic signals in centralized traffic control territory.

Trakode can also be used to control approach locking, approach indication, and electric switch locking on tracks signaled for double direction running. It may be used with all types of signals and also with intermittent inductive train control.

Due to the pulsating nature of the track energy, the track circuits can usually be considerably longer than conventional direct current track circuits. The slow rate of pulsation lengthens the service life of the code responsive relays.

Operation

To help understand the basic principles of Trakode, consider a polar track circuit having a polar-biased track relay. This relay is equipped with two armatures, one responding to each polarity of current. By pole changing the current at the transmitting end of the track circuit, two pieces of information can be sent to the relay end. This could be used to control an H or a D relay for controlling a signal. By slowly pulsating this current so that the track circuit is alternately energized for a fraction of a second and then deenergized for about two seconds, more can be accomplished as follows:

1. Track circuits can be made longer.
2. By changing polarity, positive and negative code characters are available, but by pulsating the energy, two more characters may be transmitted. This is done by pole changing the current in the middle of an energized period so that one rail is first negative and then positive in respect to the other. The order may be reversed so that positive is first. Hence these code characters are negative-positive and positive-negative respectively. At the receiving end of the track circuit, decoding units detect which of the four characters is received.
3. In the long deenergized period, the same information may be transmitted back from the relay end of the track circuit. Therefore, any one of the four characters may be used to control an opposing signal.

A pulse transmitted from a head block (end of siding) is received at the first intermediate signal, or repeating cut location, and is repeated to the next track circuit as soon as it is received. The pulse is thus repeated through a succession of track circuits until it reaches the next head block.

However, at the intermediate signals, the character of the pulse about to be repeated may be changed from that being received, to indicate the position of the intermediate signal. When this changed pulse is received at the next head block, it conditions the circuits so that a similar pulse is transmitted and repeated back to the first head block, during the deenergized period between pulses.

It must be remembered that for normal Trakode operation, only one pulse is being transmitted through a block at a time. A pulse is sent in one direction, and after it has been received at the other end, another pulse is sent back. This is termed "dependent" coding, since the transmission circuits at the end of the block are conditioned by the pulse being received so that they will transmit a pulse back as soon as reception is ended.

When a train enters a block, it prevents the transmission of pulses to the opposite end and so ends the dependent coding. It also puts all opposing signals in the block to stop. The apparatus at the opposite end of the block then transmits pulses at a fixed rate and with polarity characteristics to give the proper signal indications to the train. Such transmission is termed "independent" coding.

When Trakode is used in APB signaling, the tumbledown time of the opposing signals is not dependent upon the cascaded times of the signal mechanisms or their slow repeaters. Since the entrance of a train will release all opposing track relays almost simultaneously, the opposing signals will go to stop at the same time, regardless of the number of intermediate signals in the block. Also, failure of any intermediate signal to clear will not affect clearing of other intermediate signals between the failed intermediate and the leaving signal.

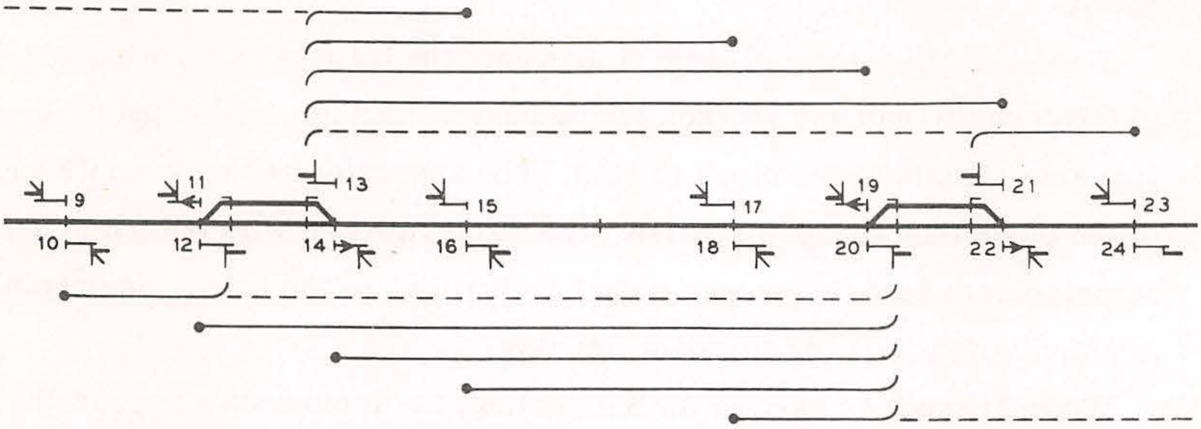
APB Signal Control

Figure 1 shows a typical APB signaling layout with control limits for opposing and following moves. This particular arrangement of controls is shown here only for the purpose of demonstrating Trakode and may be simpler or more complex than shown. The opposing stop control of entering signal 21, for example, does not have to reach all the way to the opposing leaving end, as shown.

Figure 2 shows a typical track diagram with the signaling arranged for APB operation.

The diagrams show successively how the signals are controlled by the polarized Trakode pulses as a train passes from station B to station

CONTROL LIMITS FOR OPPOSING MOVES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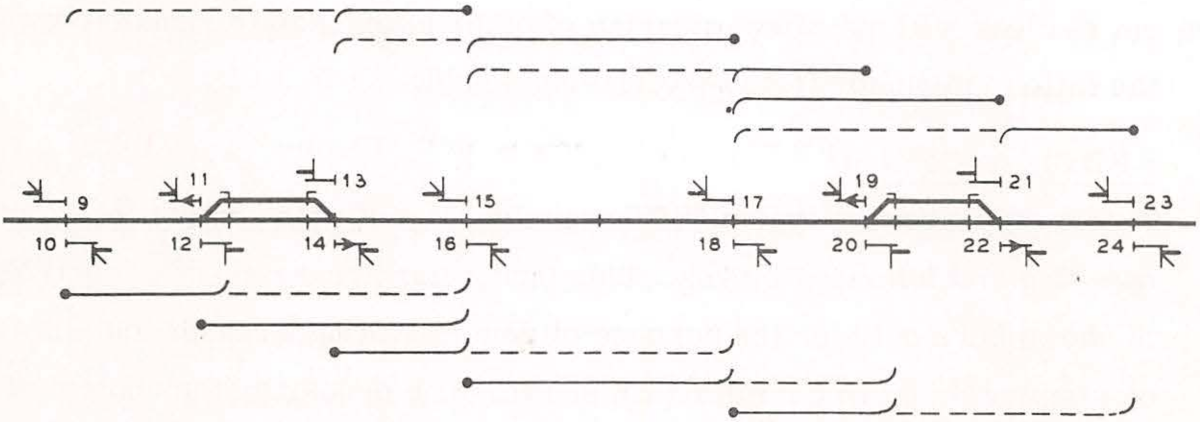
CONTROL LIMITS FOR FOLLOWING MOVES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•———— Solid line indicates limit of Stop control.

•- - - - Dotted line indicates limit of Approach control.

Figure 1. Simple APB system, showing signal controls.

C. The signal aspects are controlled by the presence or absence of coded energy in the track circuits and by the polarities of the codes as follows:

Aspects	Code
green	+
yellow	-
red	0

Diagram A shows the normal condition with no train present. All the signals are normally clear for both directions of traffic. All of the pulses for controlling the signals to green are shown as positive and are transmitted, in the direction of the arrows, alternately from station B to station C, and from C to B. The dependent coding with the repeating action from track circuit to track circuit is normally present in each section, except the detector track circuit at each siding end.

When B transmits a particular pulse to C and it is received, C in turn sends a pulse back to B with the same repeat operation. The polarity of the pulses need not be the same.

Diagram B shows a train at station B, with the block ahead of it clear to C. The dependent westbound coding behind the train has been removed, thus controlling signal 12 to the red aspect. This causes negative pulses to be transmitted in the next track circuit to the rear so that signal 10 is now at yellow, for following moves. Opposing signals 13 and 15 have likewise been controlled to red and yellow respectively.

In Diagram C, the train has moved onto the detector track circuit. The overlap has been arranged so that this removes all eastbound transmission right up to station C, and causes a tumbledown of westbound signals 13, 15, 17, 19, and 21 to red. Signal 21 at red causes negative pulses to be transmitted to signal 23, controlling it to yellow. Station

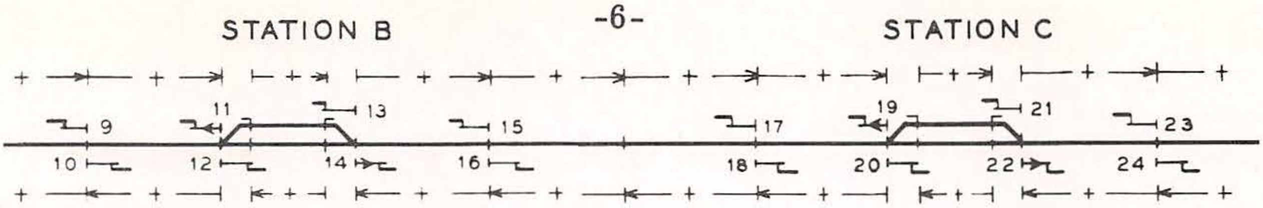
STATION B
STATION C
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Diagram A

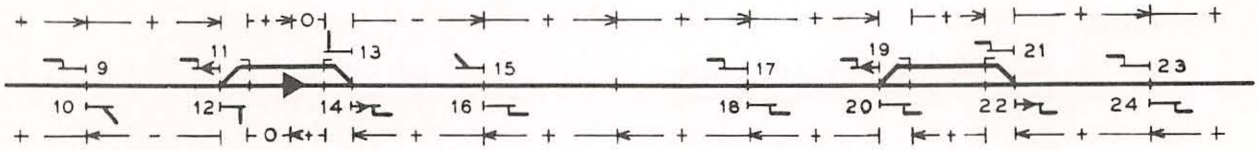
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Diagram B

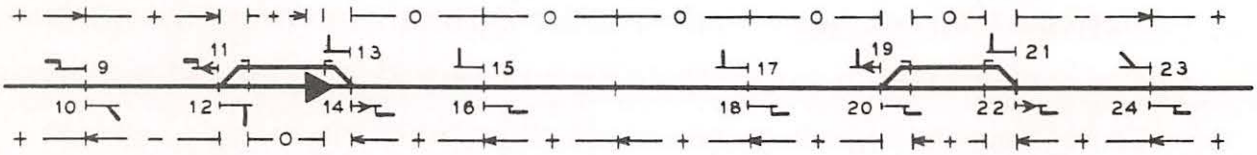
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Diagram C

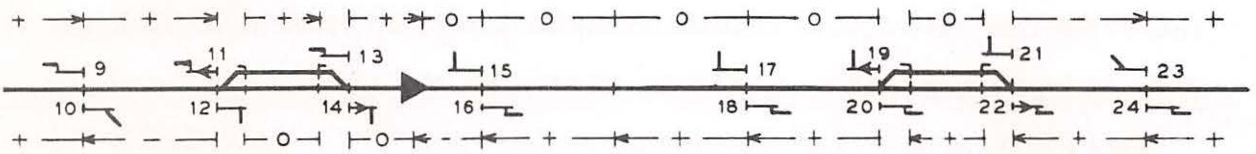
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Diagram D

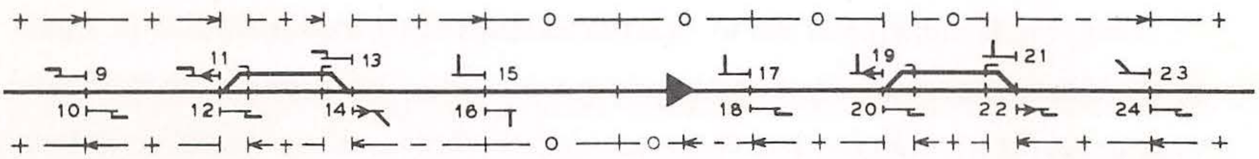
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Diagram E

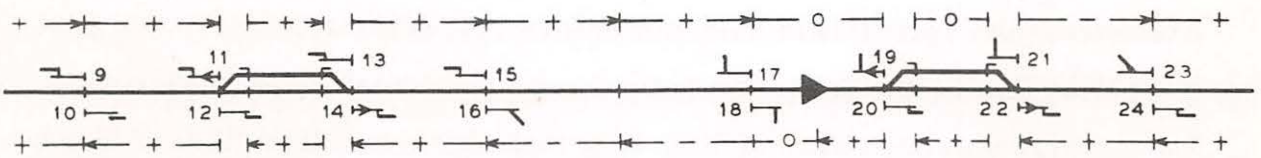
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Diagram F

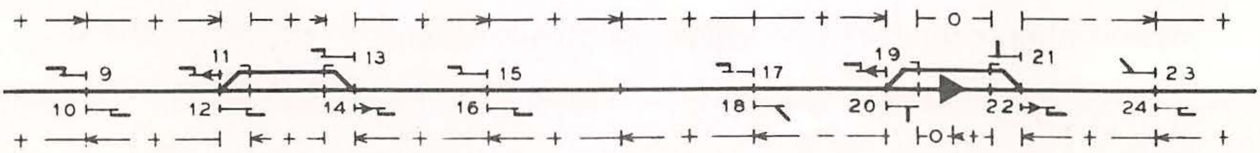
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Diagram G

Figure 2. Trakode APB signaling.

C, after waiting the normal time for pulses to arrive from B, changes to independent coding and continues to send positive pulses toward B, keeping the eastbound signals cleared for the train to proceed toward C.

In Diagram D, the train has accepted signal 14, cutting off westbound positive pulses and placing 14 at red. Signal 12 remains at red rather than changing to a yellow aspect because the train is still in the overlap limits of signal 12 as shown in Figure 1. Note that independent positive pulses are transmitted toward the train from signal 13. The train nearing signal 16 has actuated the approach circuit which changes to negative the pulses feeding from signal 16 to the train.

In Diagram E, the train has passed signal 16, leaving it at red. Signal 16 transmits negative pulses to control signal 14 to yellow for a following move, and 14 transmits positive pulses to control signal 12 to green. Note that although positive pulses are being transmitted from signal 13 to signal 15, signal 15 does not clear because of the directional stick circuit, which also prevents transmission toward signal 17. The approach-actuated stick circuit at signal 18 changes the positive pulses feeding from signal 18 toward the train to negative pulses.

In Diagram F, the train has passed signal 18, leaving it at red. Signal 18 transmits negative pulses to control signal 16 to yellow, which in turn transmits positive pulses to control signal 14 to green. Independent positive pulses feed toward the train from signal 20.

In Diagram G, the train has moved past signal 20 which thereupon goes to red and allows the negative code in the track circuit to the rear to release the directional stick relay associated with signal 18. The repeat of the pulses through all the track circuits in the block allows dependent coding to be again established upon the reception of the first pulse at signal 19.

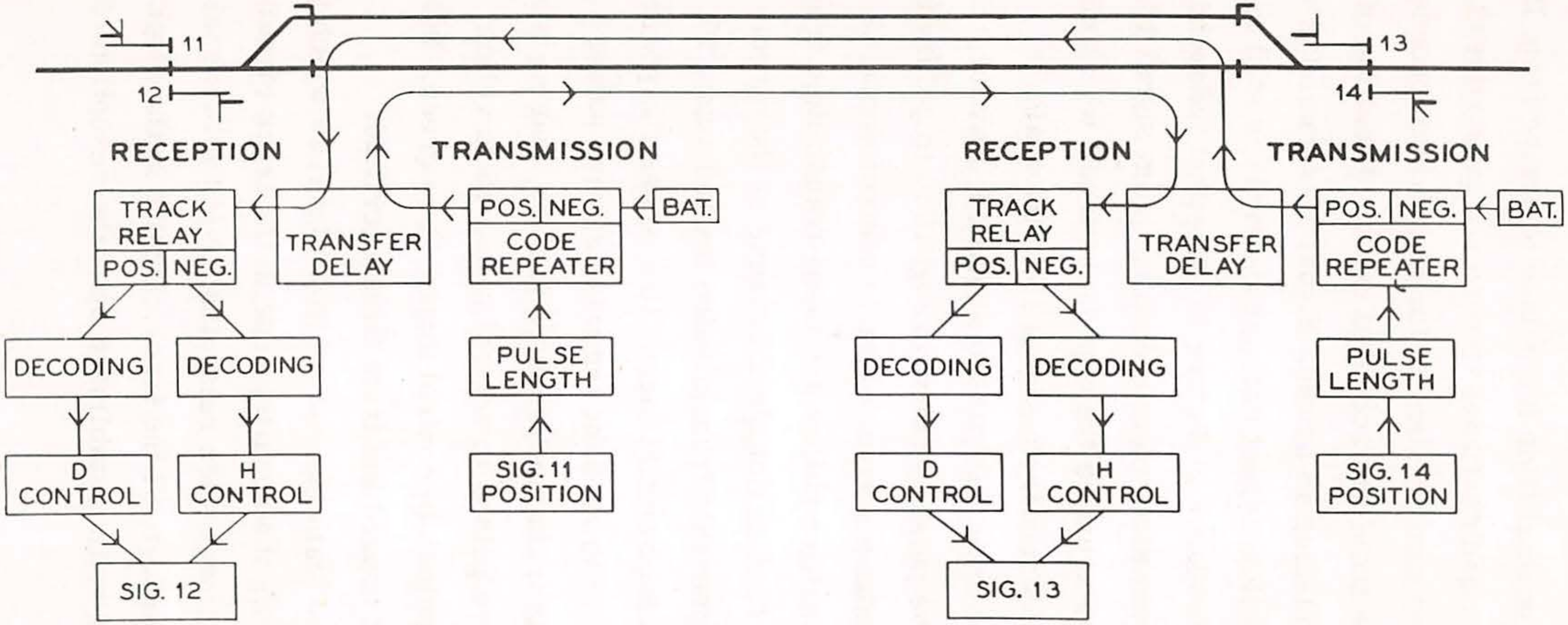

11
12
13
14
RECEPTION
TRANSMISSION
RECEPTION
TRANSMISSION
TRACK RELAY
POS.
NEG.
TRANSFER DELAY
POS.
NEG.
CODE REPEATER
BAT.
DECODING
DECODING
PULSE LENGTH
D CONTROL
H CONTROL
SIG. 11 POSITION
SIG. 12
TRACK RELAY
POS.
NEG.
TRANSFER DELAY
POS.
NEG.
CODE REPEATER
BAT.
DECODING
DECODING
PULSE LENGTH
D CONTROL
H CONTROL
SIG. 14 POSITION
SIG. 13

Figure 3. Function diagram of Trakode.

Typical Siding

The block diagram in Figure 3 shows the function organization of Trakode when applied to a typical siding. Each siding end has a detector track circuit which serves a two-fold purpose. It provides additional overlap against simultaneous entry and also isolates the two Trakode circuits, thereby protecting against the breakdown of insulated joints. The signaling is arranged for APB operation in both directions. Signals are three-position except those governing entrance to double track. These are two-position in this instance for reasons of simplicity, although Trakode is capable of controlling a third aspect if desired. For the same reasons, only two code characters, positive and negative, will be used in the circuit descriptions to follow although four characters are available.

Briefly, the transmission procedure involves the following steps:

1. The polarity of the pulses to be transmitted is determined by the position of a particular signal.
2. The length of each pulse, and therefore the rate of transmission, is predetermined.
3. The pulse, positive or negative, is generated and applied to the rails from the battery.
4. A time delay is provided between transmission and reception of successive pulses. This is to prevent a possible induced voltage from the rails (rail kick) from operating the track relay inadvertently.

At the opposite end of the track circuit, reception of the pulses takes place thus:

1. The track relay responds to the polarity of each pulse by operating one of its two armatures as indicated by POS. and NEG.
2. The pulse activates a code detecting unit which operates one of

the control relays.

3. Either the H or D signal control relay picks up, according to the pulse polarity, and remains up as long as pulses of the same polarity are received.
4. The H relay responds to negative pulses and controls the signal to the yellow aspect, and the D responds to positive pulses for a green aspect.

The simplified circuits in Figure 4 are for a typical siding as shown in the function diagram. It is assumed that conditions are normal, that is, the switches are lined for a move on the main track and the signals show the green aspect. Therefore, positive pulses are being dependently transmitted in both directions, and received to clear the two-position signals 12 and 13.

Before describing the operation to clear signals 12 and 13, it may be convenient to list the relays involved, and their functions:

T - Track relay, for reception of the pulses. This is a quick-acting polar-biased relay (Type VTB) having either one or two armatures, depending on the code requirements. One armature responds to positive pulses and the other to negative.

TD - Transfer delay relay, which provides a time delay between the transmission of a pulse and the connecting of the track relay to the rails for receiving a pulse. This delay allows the induced rail potential to dissipate through the track ballast and bleeder resistor before the track relay is connected to the rails, so it will not be falsely energized.

CP - Code repeater relay, which combines with the PL relay to generate the pulses, with polarity as determined by the position of the signal. This is a quick-acting polar-biased relay (Type VTB) with double armatures, if required. When two armatures are used, one armature creates positive pulses and the other negative.

PL - Pulse length relay, which determines the length of each pulse with the aid of the CP relay. It also determines the length of the off time between pulses with the aid of a condenser-resistor unit. This is a Type CR, code-responsive relay.

H&D - Home and distant signal control relays. Although H relays are not shown in Figure 4, they are included here for future reference in Figure 6. These are neutral biased relays which determine the aspect of the signal, H relay controlling it to yellow, and D relay controlling it to green.

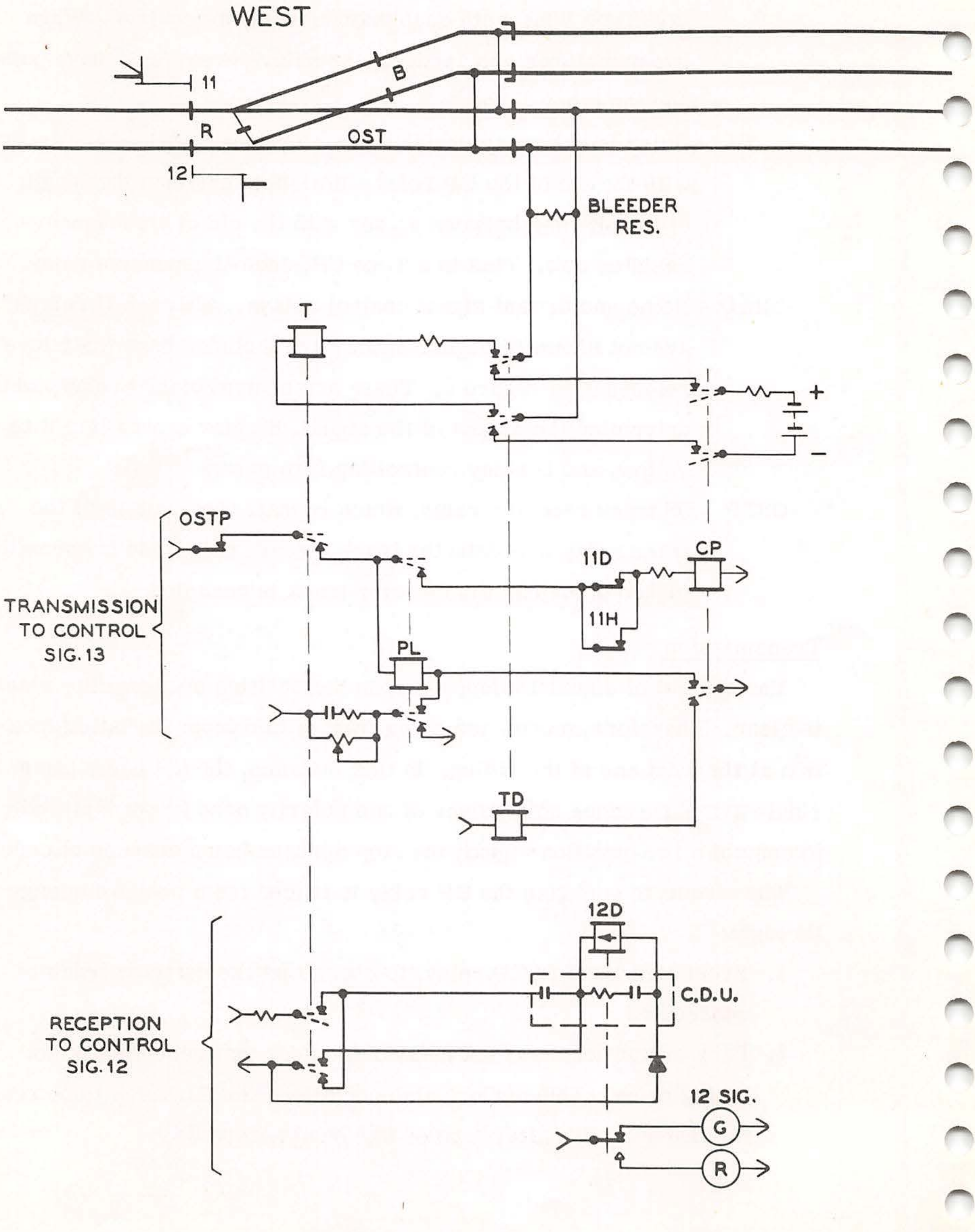
OSTP - OS track repeater relay, which repeats the position of the track relay in a detector track circuit, that is, it is normally picked up unless the detector track is occupied.

Transmission

The control of signal 13 depends upon the position of signal 11, which is clear. Therefore, pulses are being transmitted from the latter location at the west end of the siding. In this instance, the CP relay has a single armature since only pulses of one polarity need be transmitted to control a two-position signal, the stop position being absence of code.

The circuit to energize the CP relay is traced from positive energy through:

1. Front contact of OSTP relay, to check that the detector track is unoccupied.
2. Back contact of the track relay T to check that reception is not taking place. This contact also conditions the PL relay to be ready for transmission after a pulse has been received.


WEST
11
B
R
OST
12
BLEEDER RES.
T
+
−
OSTP
11D
CP
11H
TRANSMISSION TO CONTROL SIG. 13
PL
TD
12D
C.D.U.
RECEPTION TO CONTROL SIG. 12
12 SIG.
G
R

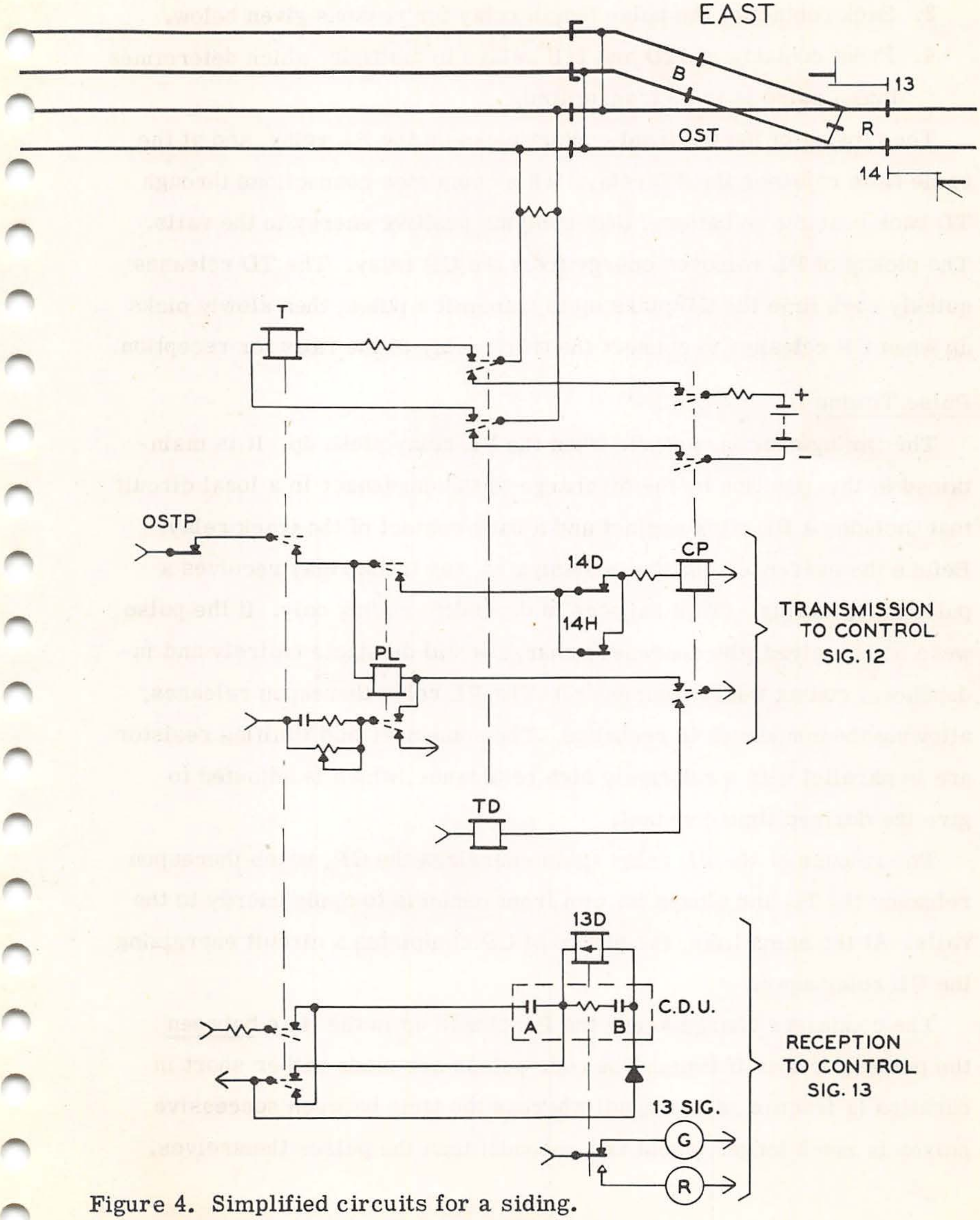

EAST
B
OST
R
13
14
T
OSTP
14D
CP
14H
PL
TD
TRANSMISSION
TO CONTROL
SIG. 12
13D
C.D.U.
A
B
RECEPTION
TO CONTROL
SIG. 13
13 SIG.
G
R

Figure 4. Simplified circuits for a siding.

3. Back contact of the pulse length relay for reasons given below.
4. Front contacts of 11D and 11H relays in multiple, which determines that a pulse is to be transmitted.

The closing of the CP front contact picks up the PL relay, and at the same time releases the TD relay. This completes connections through TD back contacts to battery, thus applying positive energy to the rails. The pickup of PL removes energy from the CP relay. The TD releases quickly each time the CP picks up to transmit a pulse, then slowly picks up when CP releases to connect the track relay to the rails for reception.

Pulse Timing

The timing operation starts when the PL relay picks up. It is maintained in this position by the discharge of the condenser in a local circuit that includes a PL stick contact and a back contact of the track relay. Before the condenser charge is dissipated, the track relay receives a pulse and picks up. (This happens in dependent coding only. If the pulse were not received, the condenser charge would dissipate entirely and independent coding would commence.) The PL relay thereupon releases, allowing the condenser to recharge. The condenser and limiting resistor are in parallel with a relatively high resistance, which is adjusted to give the desired time constant.

The release of the PL relay again energizes the CP, which thereupon releases the TD and closes its own front contacts to apply energy to the rails. At the same time, the pickup of CP completes a circuit energizing the PL relay again.

The condenser charge keeps the PL picked up in the time between the pulses, or the off time. The code pulses are made rather short in duration (a fraction of a second) whereas the time between successive pulses is much longer (about two seconds) than the pulses themselves.

The intermittent pickup and release of the CP relay is continued as long as the detector track is unoccupied, reception is taking place at the proper time, and signal 11 is at either green or yellow aspect.

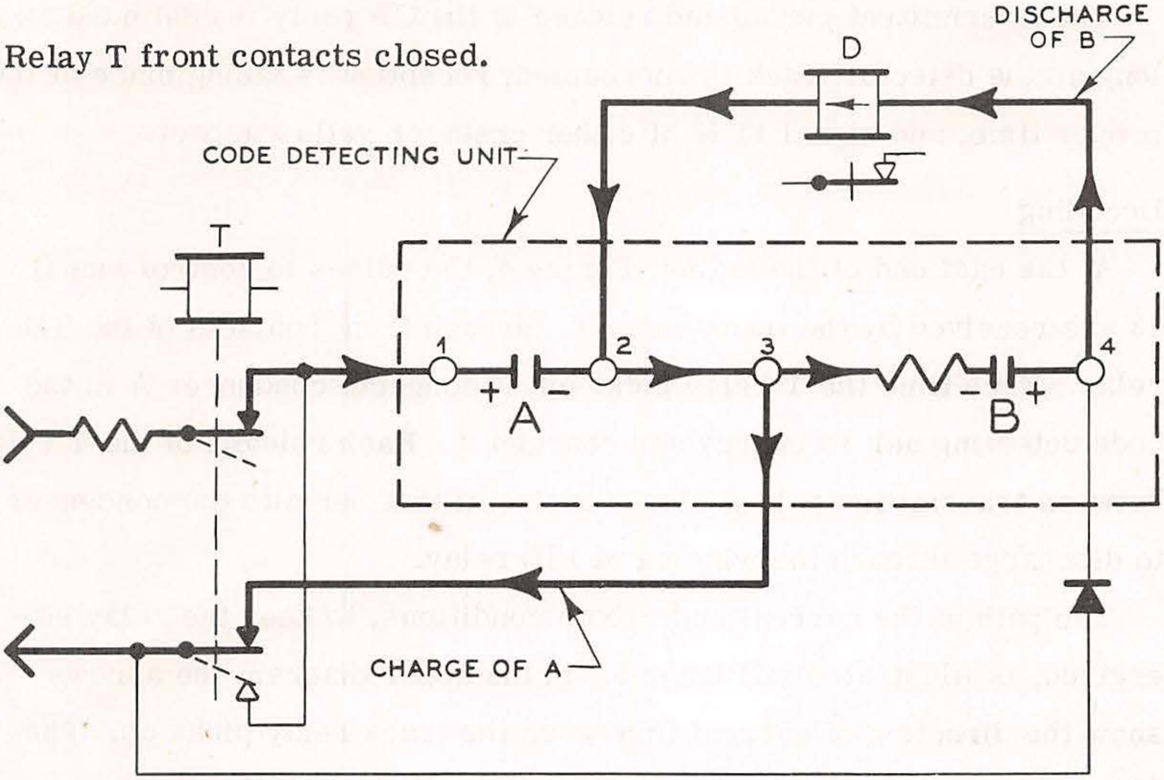
Decoding

At the east end of the siding, Figure 4, the pulses to control signal 13 are received by the track relay T, through front contacts of the TD relay. Each time the T relay picks up, it connects condenser A in the code detecting unit to energy and charges it. Each release of the T relay between transmitted pulses closes a circuit that permits the condenser to discharge through the winding of 13D relay.

The path of the current under both conditions, to keep the relay energized, is illustrated in Figure 5. In the upper diagram the arrows show the direction of current flow when the track relay picks up. The 5000 mfd. condenser A is charged by a circuit through the connection between terminals 2 and 3. The previously charged condenser B, which is 1000 mfd., is discharged through the relay winding and keeps the relay picked up during the time a pulse is received. The rectifier prevents condenser B from discharging through a front contact of T relay.

In the lower diagram, the arrows show the direction of current flow in an interval between successive pulses when the T relay is released. Condenser A discharges through the relay winding, the polarity of current being such that the biased-neutral relay is energized to keep it picked up. A parallel circuit charges condenser B at the same time.

Thus, in the short interval when a pulse is received, the relay is energized by condenser B and in the longer interval between pulses, is energized by condenser A. If coding ceases, the condensers will not be charged and the relay will release. If steady energy is received inadvertently from the rails, the track relay will pick up and stay up. However, Relay T front contacts closed.


DISCHARGE OF B
D
CODE DETECTING UNIT
T
1
2
3
4
+
A
−
−
B
+
CHARGE OF A

Relay T back contacts closed.

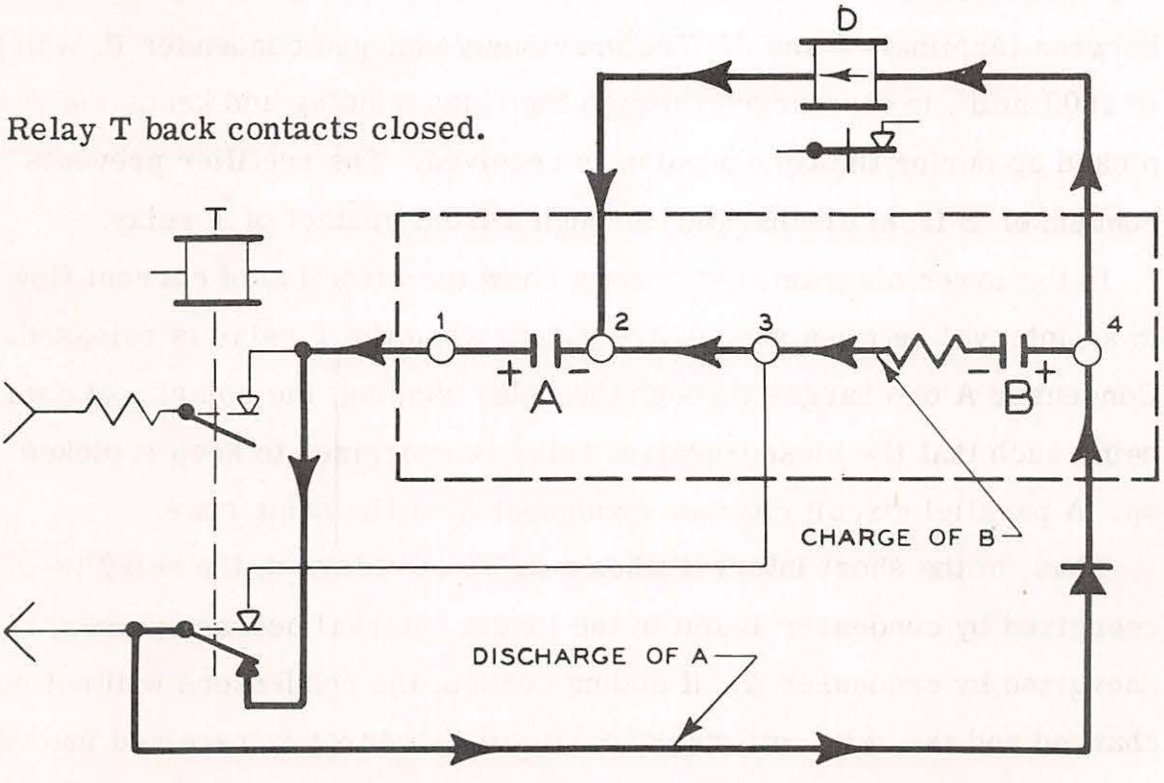

D
T
1
2
3
4
+
A
−
−
B
+
CHARGE OF B
DISCHARGE OF A

Figure 5. Decoding operation.

condenser A will not be permitted to discharge, and the relay will release when the charge of condenser B is dissipated. This provides protection against storage-battery effect in the track.

The D and H signal control relays used in such decoding circuits are biased neutral as a precaution against possible breakdown of the condensers.

Independent Coding

The description thus far has dealt with dependent coding, that is, the track relay must pick up and release the PL relay so the condenser may be charged for the next transmission, which will start when the track relay releases. However, if a pulse is not received in the predetermined length of time, independent transmission takes place.

Referring to Figure 4, assume an eastbound train occupies the detector track at the west end of the siding. The OSTP relay releases and prevents further operation of the CP relay. Hence transmission stops.

At the other end of the track circuit, the track relay remains released, so the pulse length relay PL is held picked up until the condenser charge dissipated. Its release closes the pickup circuit for the CP relay. The transmission operation proceeds as described before, except that the track relay is inoperative and the discharge time of the condenser determines when the next pulse is to be transmitted.

At the west end of the siding, when the train leaves the detector track the OSTP relay picks up and allows signal 11 to clear. Thus the pickup circuit of the CP is again established and pulses are independently transmitted up to the rear of the train.

When traffic conditions return to normal, transmission at both ends is quickly brought into step for dependent coding. To facilitate this, the rate of independent coding at one end is different from the rate at the

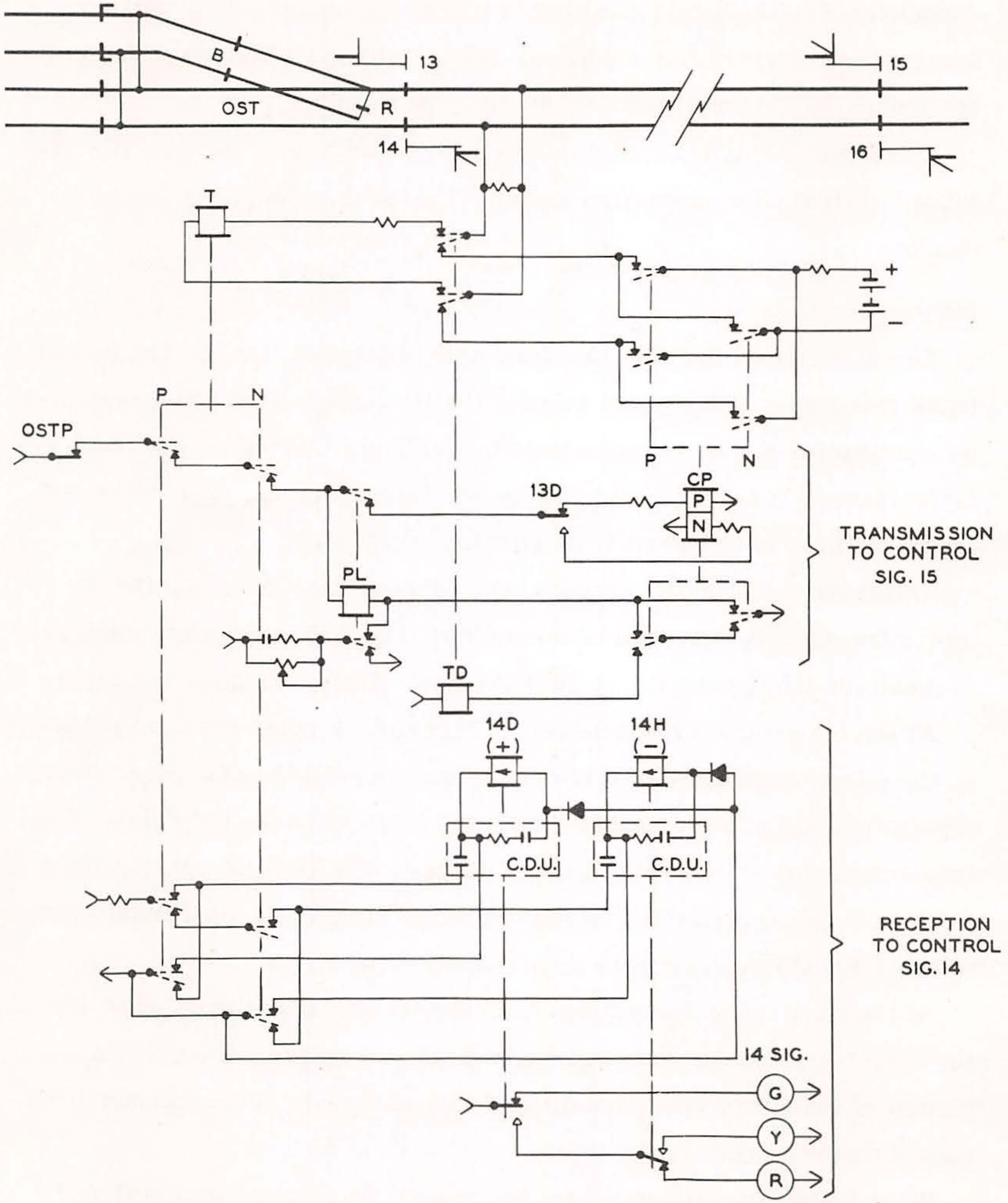

B
OST
R
13
14
15
16
T
P
N
OSTP
P
N
CP
P
N
13D
PL
TD
TRANSMISSION TO CONTROL SIG. 15
14D
(+)
14H
(−)
C.D.U.
C.D.U.
RECEPTION TO CONTROL SIG. 14
14 SIG.
G
Y
R

Figure 6. Circuits to control 3-position signals.

other end, for example, 33 pulses per minute as compared to 29 pulses per minute. The faster rate has an opportunity to be received at the other end and return the system to dependent coding.

Control of 3-Position Signals

The circuits in Figure 6 are a continuation of those for the siding. They will serve to show how both positive and negative pulses are transmitted and received to control three-position signals. For example, information about signal 13 is transmitted eastward to control intermediate signal 15, and signal 14 is controlled by transmitting information west concerning signal 16.

In this case, the CP relay and the track relay have double armatures, one responding to positive pulses and the other to negative. Otherwise the operation is much the same as described previously.

In transmission to control signal 15, the circuit to energize the CP is the same as before except that closing the front contact of signal control relay 13D will operate the positive armature of CP relay, and the release of 13D operates the negative armature. Therefore, when 13 signal is green, a positive pulse is transmitted to control 15 signal to green, and when 13 is red, a negative pulse is transmitted to control 15 to yellow. Occupancy of the detector track circuit will, of course, release OSTP relay, place all opposing signals at stop, and start independent coding as shown in Diagram C, Figure 2.

In the decoding operation to control signal 14, the position of signal 16 determines whether a positive or negative pulse will be received, and therefore which armature of the track relay will operate. If the pulses are positive, signal control relay 14D picks up and remains up in the same manner described previously, and signal 14 will be green. If negative, 14H relay is energized, and signal 14 is yellow.

Figure 7 shows the circuits for a double intermediate signal location. In addition to the relays discussed so far, others are required for direction control purposes:

AR - Series approach relay, which repeats the code when a train is approaching, and thereby picks up the proper directional stick relay. This relay has two windings, one for each direction.

S - Directional stick relay, with prefix denoting east or west. In picking up, this relay records the direction of a train passing an intermediate signal location.

FS - Traffic stick relay, with prefix denoting east or west. One of these normally energized relays is required for each intermediate signal. When a train enters the block between sidings, all the opposing traffic stick relays are released, thus establishing the direction at all locations in the block.

With the signals clear as shown, positive pulses are being transmitted dependently. A pulse received by the track relay WT, for example, applies energy to the ECP relay, so that the pulse is repeated into the adjacent track circuit. The reception of a negative pulse will usually result in transmission of a positive pulse. The pulse is always passed on, but its character may be changed, since this depends upon the position of the signal. The ECP pickup circuit to relay the pulse is taken through back contacts of the ET to check that reception is not taking place, through back contacts of directional stick relays ES and WS to check that there is no traffic, and through the positive front contact of WT to positive coil of ECP.

This operation is a simple repeat of the pulse received; there is no pulse timing involved in dependent coding. In like manner, the reception of a pulse by ET will cause WCP to transmit through a circuit similar to that described.

When a train enters the block between sidings, the tumbledown feature of Trakode places all opposing signals in the block at stop. Assume an eastbound train enters the block in which the intermediate signals W and E are located and signal W therefore goes to stop.

The release of the control relay WD opens the holding circuit of the opposing traffic stick relay WFS, which thereupon releases. Nothing happens now until the train is close enough to the location so the shunt current becomes large enough to start the approach relay coding. The initial pickup of AR energizes the directional stick relay ES which is then held picked up as the AR (E) contact operates, because of the condenser-resistor shunt making it slow-release. This ES pickup circuit checks that the opposing directional stick WS is released and its own traffic stick EFS is picked up.

As the train passes the intermediate location, the signal control relay ED releases placing signal E at stop. This establishes a stick circuit for the ES relay, by-passing the AR (E) contact, through back contacts of the ED and EH relays.

When the train is past the location, the WCP transmits negative pulses west to place the signal in the rear at yellow for a following move. With the ES picked up and WFS now released, as described, a circuit is completed to energize the negative coil of WCP relay. This can be traced from positive energy through back contacts of WT, to check that reception is not taking place, through contacts of WS released and EFS picked up, for reasons given before, through back contacts of WFS and PL relays, through a front contact of ES and through the WCP negative coil to negative energy.

At the same time that WCP is energized to apply the negative pulse to

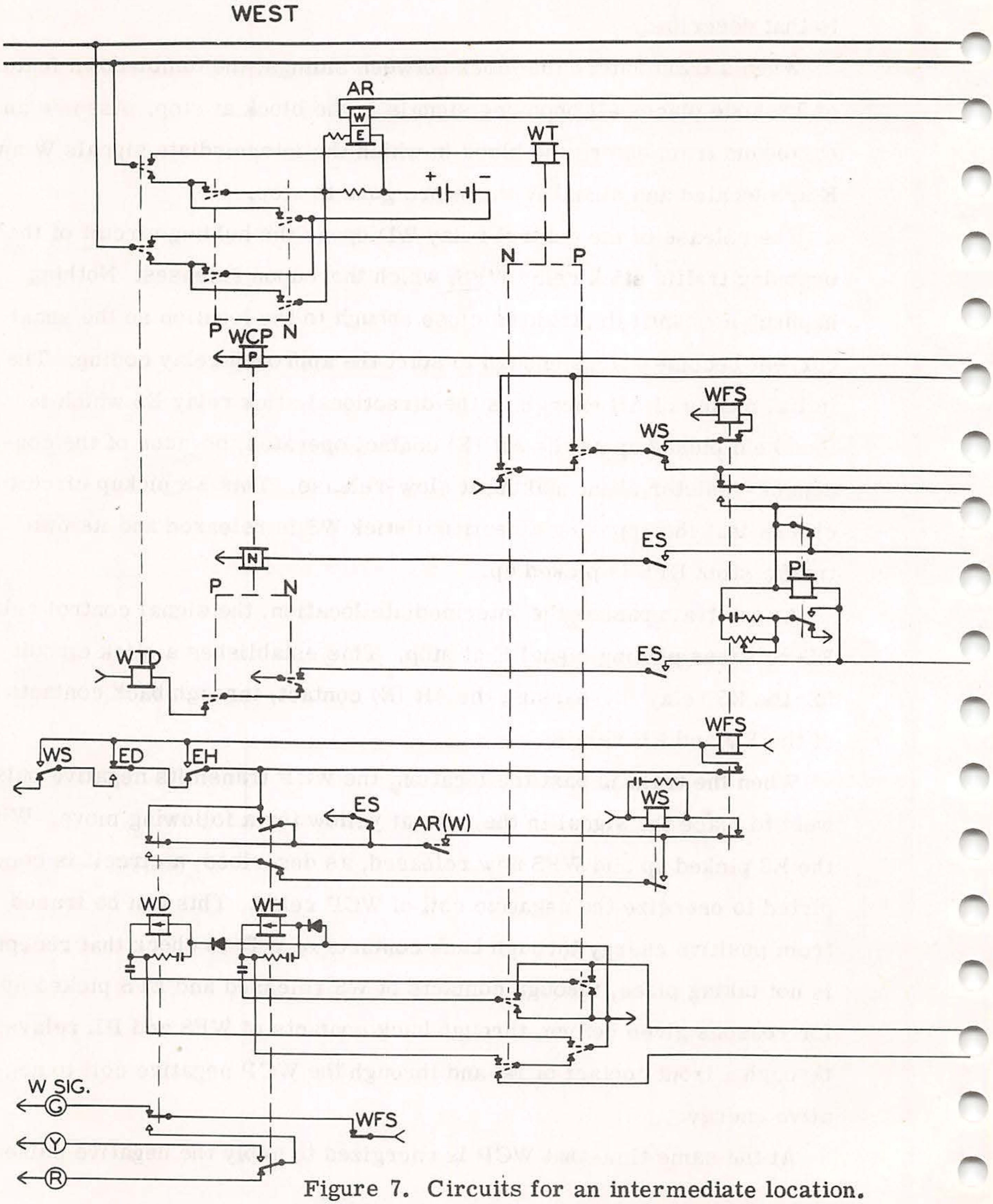
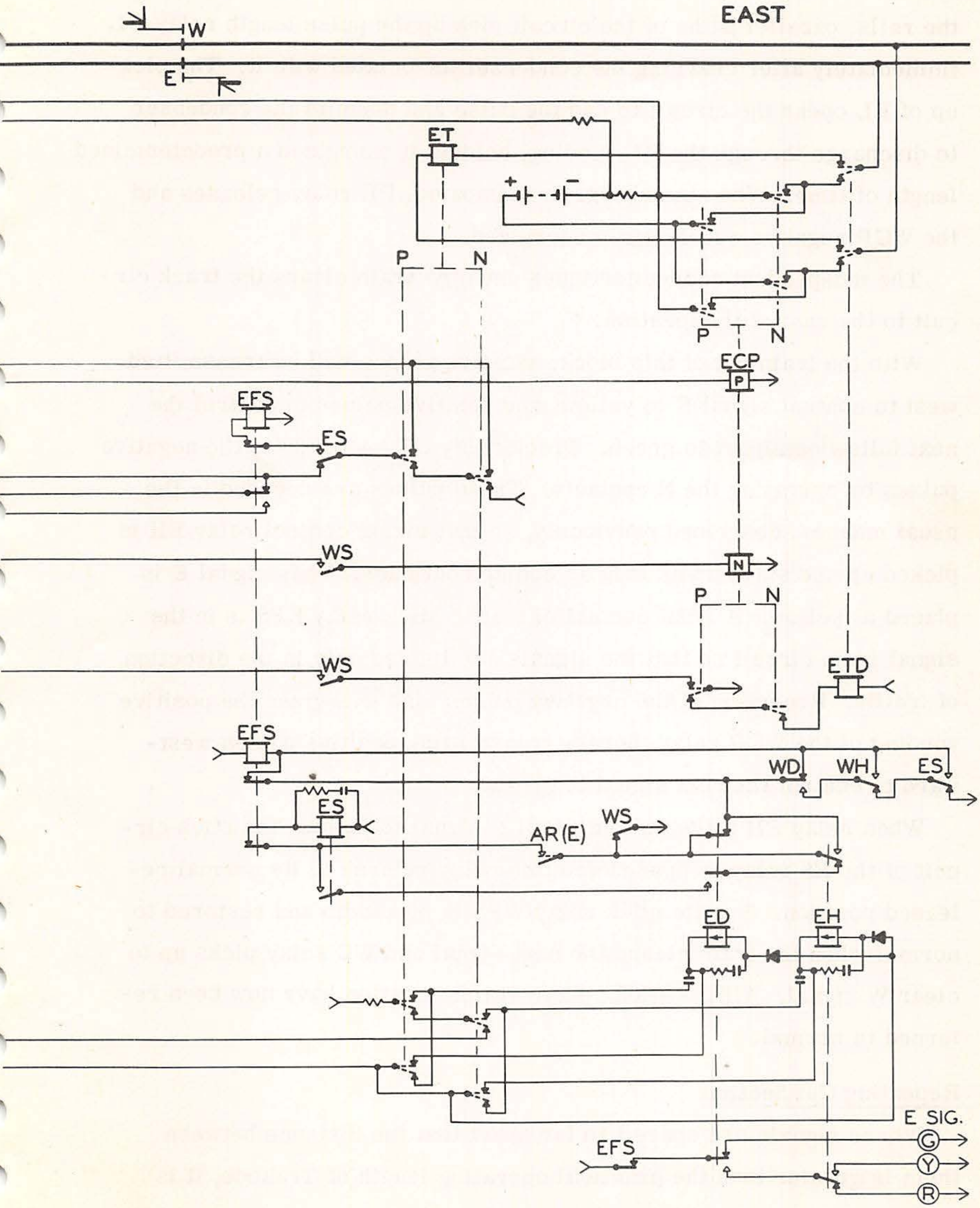

WEST
AR
W
E
WT
+
-
N
P
P
WCP
N
P
WFS
WS
N
ES
PL
P
N
WTD
ES
WFS
WS
ED
EH
WS
ES
AR(W)
WD
WH
W SIG.
G
Y
R
WFS

Figure 7. Circuits for an intermediate location.


EAST
W
E
ET
+
−
P
N
P
N
ECP
P
EFS
ES
WS
N
P
N
WS
ETD
EFS
WD
WH
ES
ES
WS
AR(E)
ED
EH
E SIG.
EFS
G
Y
R

the rails, parallel paths of the circuit pick up the pulse length relay PL immediately after charging the condenser associated with it. The pick-up of PL opens the circuit to end the pulse and permits the condenser to discharge through the PL winding, holding it energized a predetermined length of time. When the charge is dissipated, PL relay releases and the WCP negative coil is again energized.

The independent coding continues until the train clears the track circuit to the east of the location.

With the train out of this block, negative pulses will be transmitted west to control signal E to yellow, and positive pulses to control the next following signal to green. Track relay ET responds to the negative pulses by operating the N contacts. These pulses are decoded in the usual manner, described previously, so that signal control relay EH is picked up and stays up as long as coding continues. Thus signal E is placed at yellow. A front contact of traffic stick relay EFS is in the signal lamp circuit so that the signals are lighted only in the direction of traffic. Reception of the negative pulses also energizes the positive winding of the WCP relay thereby transmitting positive pulses westward to control the next signal to green.

When relay EH picks up to control E signal to yellow, the stick circuit of the ES relay is opened and this relay returns to its normal released position. Traffic stick relay WFS is picked up and restored to normal when the train clears the next signal and WD relay picks up to clear W signal. All the stick relays at this location have now been returned to normal.

Repeating Cut Section

Where signals are spaced so far apart that the distance between them is greater than the practical operating length of Trakode, it is necessary to introduce one or more code-repeating cut sections between the signals.

Two track relays having double armatures are used at each cut section. Pulses are received by one track relay on condition that the other is not receiving pulses from the opposite direction. The relay receiving the pulse then operates its positive or negative armature in response to the polarity of the pulse, and in so doing, applies the same battery polarity to the rails in the adjacent track circuit.

GENERAL RAILWAY SIGNAL COMPANY

TRANSISTORS USED IN CODED CAB SIGNAL SYSTEM

The transistor is a new device based upon the properties of certain semi-conductors (a semi-conductor is a substance which is neither a good conductor nor a good insulator). There are a number of materials of this sort, but at present the element germanium is most commonly used for transistors. The development of the first transistor was publicly announced by Bell Telephone Laboratories in June, 1948. Up to that time, semi-conductors had been used only as rectifiers, and their full capabilities had not been utilized. In the transistor, additional properties of these materials have been utilized to obtain amplification action similar in many ways to that performed by vacuum tubes. Already they have replaced vacuum tubes in many electronic circuits. The device is small, and potentially very rugged; moreover, it consists of materials which may be expected to last indefinitely. The principal limitations of the transistor are inherent manufacturing problems, sensitivity to temperature, and low power handling capacity. Substantial progress has been made in reducing these difficulties, but they have not as yet been eliminated. Greater application to commercial equipment is to be expected with increased availability.

Recently, transistors have been applied to cab signaling. Cab signal amplifilters have been placed in service in which amplification of the track code picked up by the locomotive receivers is accomplished by transistors rather than by the vacuum tube (or tubes) used previously.

Introduction To Transistors

The transistor introduced originally was known as the point-contact type. The arrangement of this type is shown in Figure 1. Two fine wire probes (cat whiskers) are arranged in contact with the surface of a pel-

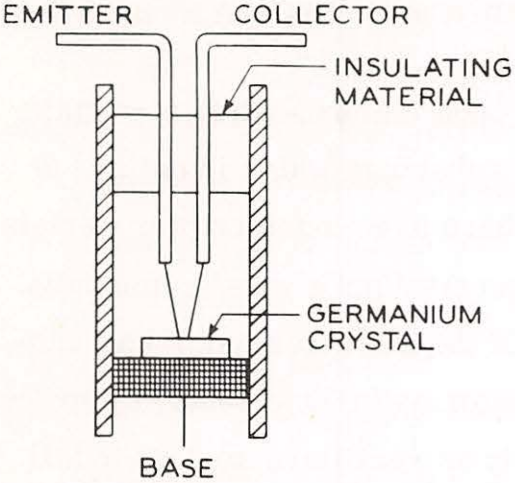

EMITTER
COLLECTOR
INSULATING MATERIAL
GERMANIUM CRYSTAL
BASE

Figure 1. Point-contact transistor.

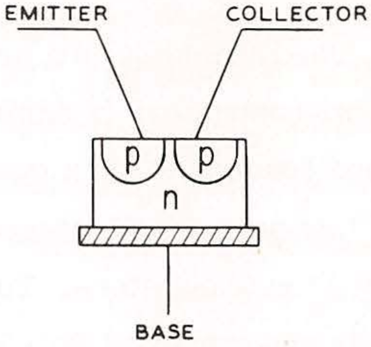

EMITTER
COLLECTOR
p
p
n
BASE

Figure 2. Point contact transistor (schematic).

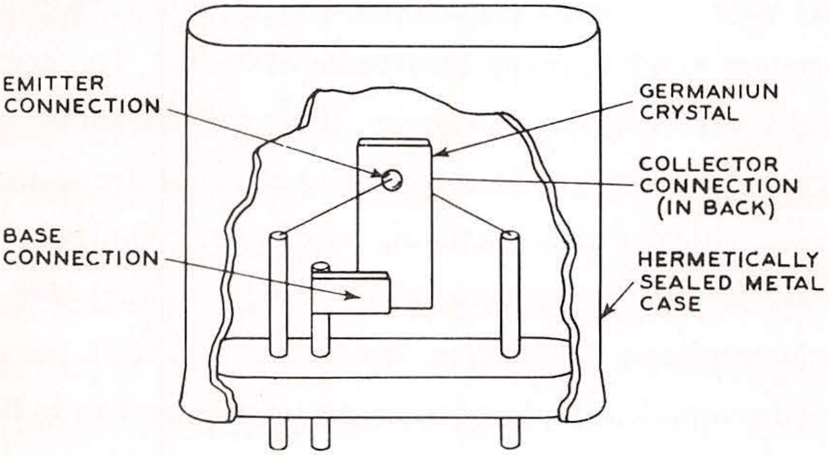

EMITTER CONNECTION
BASE CONNECTION
GERMANIUN CRYSTAL
COLLECTOR CONNECTION (IN BACK)
HERMETICALLY SEALED METAL CASE

Figure 3. Junction transistor.

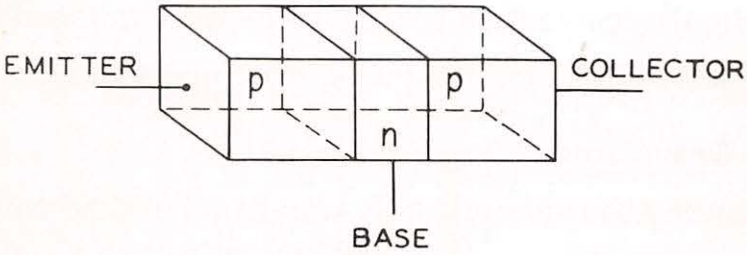

EMITTER
p
n
p
COLLECTOR
BASE

Figure 4. Junction transistor (schematic).

let of germanium semi-conducting material, with the points of contact separated by only a few thousandths of an inch. These two contacts are called the "emitter" and the "collector", while the metal which provides the electrical connection to the semi-conductor block is called the "base". The entire assembly is embedded in wax and sealed in an impregnated case with three external connections. In some cases the transistor is hermetically sealed in an evacuated shell. The point-contact type is illustrated schematically in Figure 2.

In 1951 the junction type transistor was announced. This new form of semi-conductor triode overcame several of the limitations of the point-contact type and has many more applications in electronic circuits. Figure 3 illustrates the structure, while Figure 4 is a schematic representation of the junction transistor. It differs from the point-contact transistor in that the structure involves boundaries or junctions between two different types of germanium semi-conducting material. These two types are called "n" type and "p" type, and result from the nature of certain impurities introduced into the otherwise pure material. In the n-type germanium, impurities of arsenic, antimony, or phosphorus are usually introduced which contribute free electrons to the germanium crystals. These free electrons move under the action of an electric field (voltage difference) and produce an electric current. In the p-type, impurities such as aluminum, boron, and indium are added. This causes a deficiency of electrons at places where they would normally be present in a perfect crystal. The locations of the missing electrons are called "holes", which behave in many ways like positive charges. Like the electrons, these can also move through the germanium crystal but are attracted to a negative electrode.

The junction transistor is called a "p-n-p" junction type if the layers occur in the order shown in Figure 4. However, the p- and n- regions may be interchanged, resulting in an "n-p-n" type. The latter is in the form of a narrow p- type region between two n-type regions. The schematic circuit symbols for these two types are shown in Figure 5.

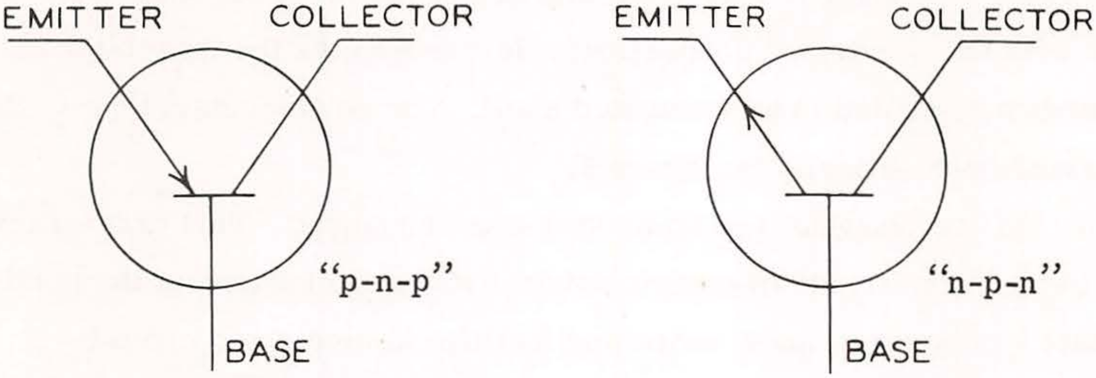


Figure 5. Schematic circuit symbols for "p-n-p" and "n-p-n" junction type transistors.

The point-contact and junction transistor each have certain advantages and disadvantages. The point-contact transistor is generally better suited to high frequency work, and is used as a switch and storage element. The junction transistor is equally satisfactory at low frequencies, and offers superior mechanical and electrical stability, high gain per stage, and relatively low noise level.

The transistor can perform almost all of the functions of a vacuum tube yet is not subject to many of the limitations of the vacuum tube. It is free from microphonics, resistant to the effects of shock and vibration, and has potentially long life. As the transistor does not need a heated cathode to produce electrons for its operation, no heater is required. Consequently, it is very economical of energy and requires no warm-up time. It will operate from low-voltage power supplies ranging from 1 or 2 volts up to 20 or 30. As shown in Figure 6, it is much smaller and lighter than vacuum tubes.

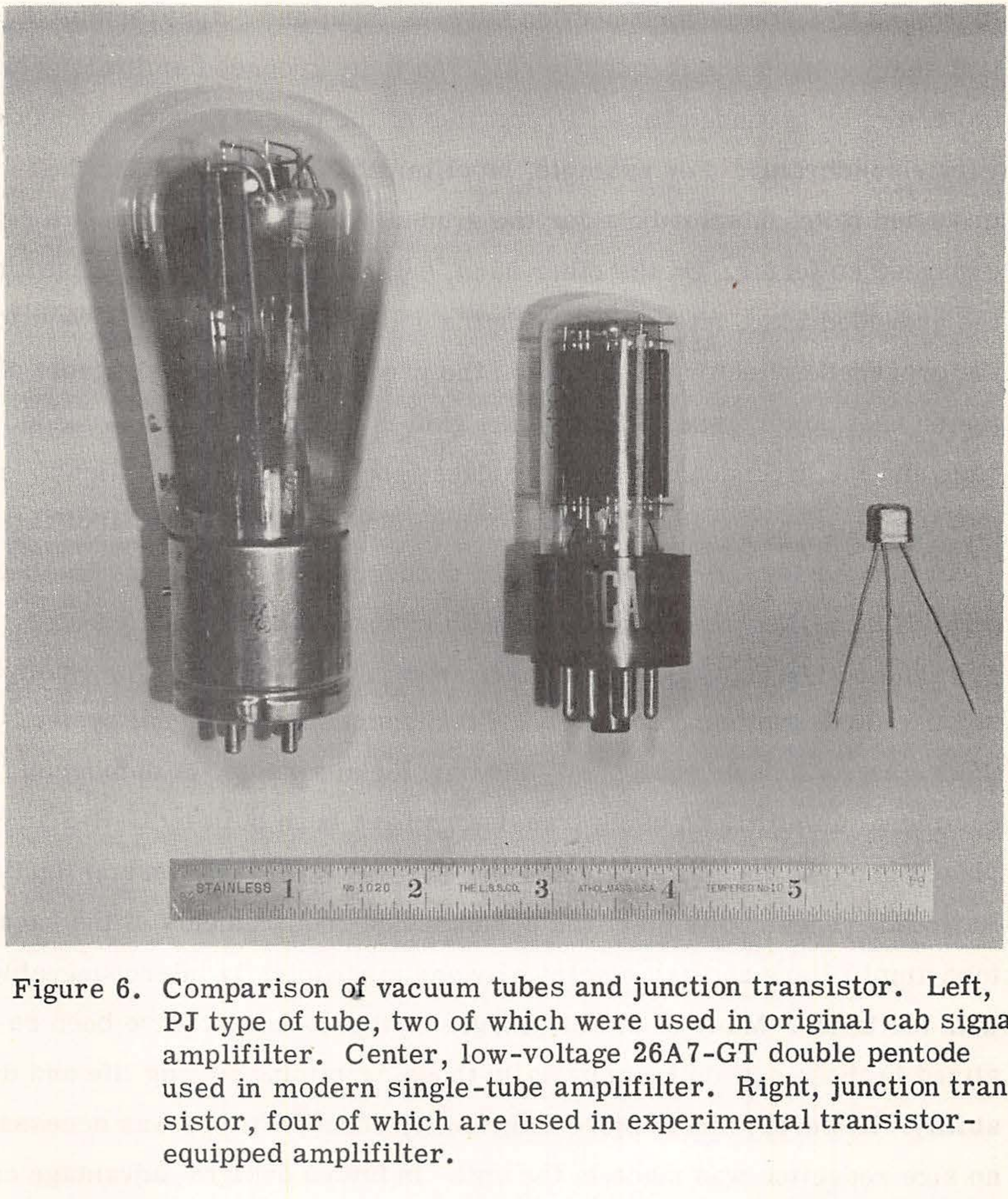


Figure 6. Comparison of vacuum tubes and junction transistor. Left, PJ type of tube, two of which were used in original cab signal amplifilter. Center, low-voltage 26A7-GT double pentode used in modern single-tube amplifilter. Right, junction transistor, four of which are used in experimental transistor-equipped amplifilter.

The performance of a transistor depends to a great extent on the manner in which it is connected. Circuits have been designed in which the emitter, collector, or base is connected to the common conductor between the input and the output terminals, with varying operating characteristics as a result. As it is common practice in amplifier design to ground this common connection between input and output terminals, transistor stages are frequently referred to as grounded emitter, grounded collector, or grounded base. Properties of the three types of connection vary considerably. For example, input impedance is lowest for the grounded base, intermediate for the grounded emitter and highest for the grounded collector. On the other hand, output impedance is highest for the grounded base, intermediate for the grounded emitter and lowest for the grounded collector. In addition, the grounded emitter is capable of the highest power gain. Slightly less gain is produced by the grounded base and the grounded collector produces the lowest. The particular circuit used depends on the characteristics required for a given application.

Until recently, most of the limited production of transistors has been utilized in military equipment, but with increased production greater civilian applications are possible. In the railroad industry, for example, service tests are being conducted of transistors in cab signal systems, dispatcher telephone equipment, and carrier apparatus. A number of cab signal amplifilters using transistors have been built by G-R-S and placed in experimental service on the New York, New Haven and Hartford Railroad. These units meet the performance requirements of the vacuum-tube amplifilters and are electrically and mechanically interchangeable with the latter. Many of the advantages of the transistor have been realized in these new units, especially those pertaining to long life and durability. However, since interchangeability of amplifilters was necessary, no size reduction was made in the unit. In future designs, advantage can be taken of the compactness of the transistor to build amplifilters of substantially reduced size.

The Transistor Amplifilter

The transistor amplifilter operates, as its name implies, as a filter

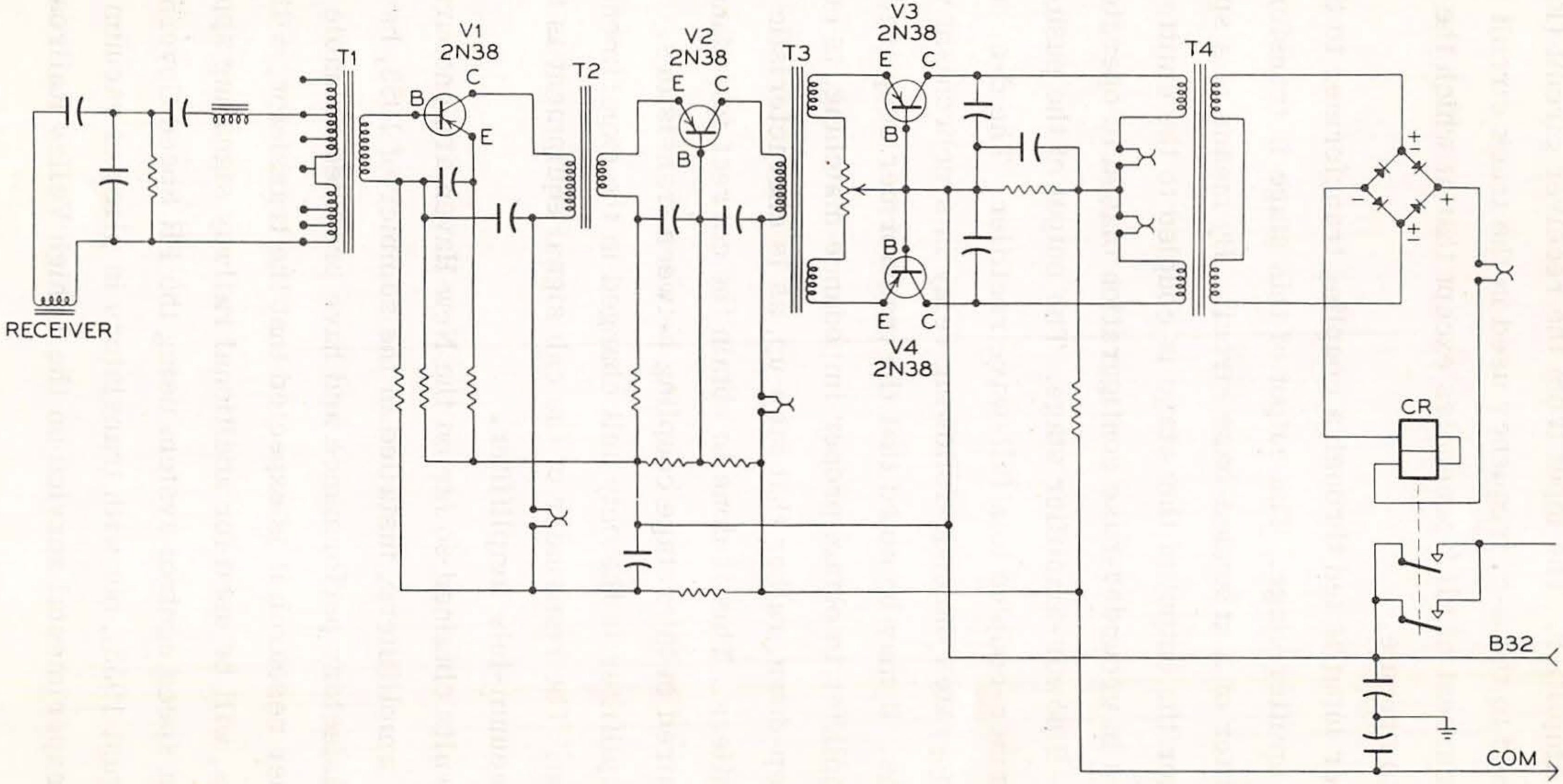

V1
2N38
B
C
E
T1
T2
V2
2N38
E
C
B
T3
V3
2N38
E
C
B
B
E
C
V4
2N38
T4
+
-
+
+
RECEIVER
CR
B32
COM

Figure 7. Transistor amplifilter typical circuit.

and as an amplifier. The input from the receiver circuit (Figure 7) is series-tuned to the a-c. frequency used in the track circuit in order to suppress current of all frequencies except that at which the cab signal is designed to operate.

Receiver input is fed through a coupling transformer to the base of a grounded-emitter stage. The output of this stage is transformer-coupled to the emitter of a grounded-base circuit. By means of a split-secondary transformer the output of this stage is coupled to the emitters of two transistors in grounded-base configuration biased to operate as a push-pull class-B power-amplifier stage. The output of the push-pull stage is transformer-coupled to a full-wave rectifier. The d-c. output of the rectifier operates the code-following relay in synchronism with track code pulses. It may be noted that the transformer coupling, used throughout the amplifier to obtain proper impedance matching, is connected for voltage step-down, rather that step-up, as is characteristic in vacuum-tube amplifiers. This is done to obtain the correct impedance relationships required in interstage coupling between transistors.

The amplifilter is the only unit changed in the experimental New Haven installation. The remainder of the cab signal equipment is the same as with the vacuum-tube amplifilter.

The results obtained so far on the New Haven are encouraging. Two transistor amplifilters, installed in the summer of 1953, have given generally satisfactory performance and have provided valuable experience. With further research it is expected that the transistor, with its inherent advantages, will be used for additional railway signaling applications. For example, a speed control system using the FR Speed Governor (see G-R-S News, August 1953), but with transistors in place of vacuum tubes, was placed in experimental service on the Lehigh Valley Railroad in

November 1953. Preliminary experience with these new installations indicates that in this application, as in the cab signal amplifilter, the transistor offers real advantages over the vacuum tube.

GENERAL RAILWAY SIGNAL COMPANY

GRS NEWS
May 1957

In this issue:

GRS Indiscan System

Outside Bumper Plates on Dragging Equipment Detector

Compact Terminal Block

GRS INDISCAN SYSTEM

Purpose

This unique electronic indication system provides a simple, fast, and economical means of sending a number of indications, such as track occupancies, from wayside locations to a control office. It uses a minimum amount of apparatus, operates continuously, and requires only two line wires.

Equipment

At the control office, or any receiving location, a standard 75-rate oscillating code transmitter is used to pole-change direct-current energy that is fed to the line wires from a battery or power supply.

One transmitter and an associated receiver can control two indications. The transmitter is a simple oscillator using one transistor, generating a single narrow-band carrier frequency. It requires one function relay contact per indication to turn it on and off. The associated receiver is also transistorized and responds to that frequency only.

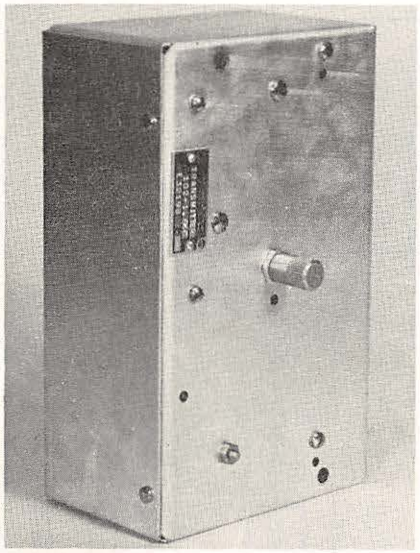


Figure 1. Transmitter unit, Dwg. 29802.

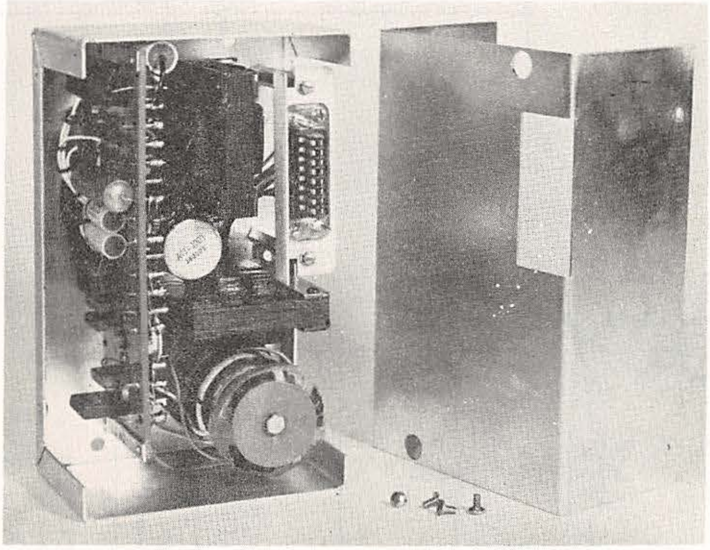


Figure 2. Receiver with cover removed, Dwg. 29803.

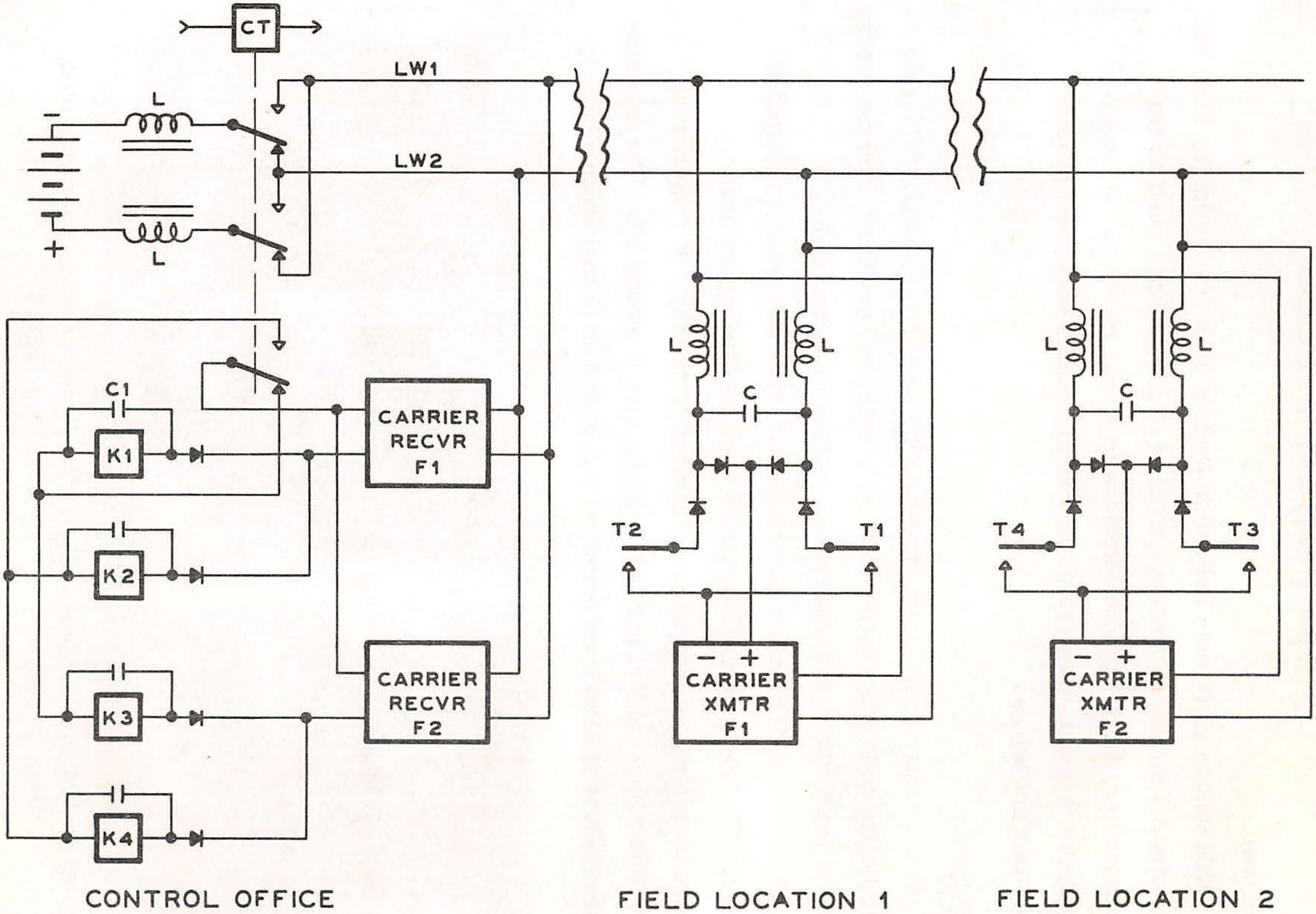

CT
LW1
LW2
L
L
C1
K1
K2
K3
K4
CARRIER RECVR F1
CARRIER RECVR F2
L
L
C
T2
T1
– +
CARRIER XMTR F1
L
L
C
T4
T3
– +
CARRIER XMTR F2
CONTROL OFFICE
FIELD LOCATION 1
FIELD LOCATION 2

Figure 3. Diagram of indiscan system.

The presence or absence of a signal actuates an indication. Two indication relays are controlled by each receiver.

Transmitter and receiver units (see Figs. 1 & 2 for prototypes) are plug-coupled. Each occupies space of a Type B1 relay. They may be wall-mounted on a B relay rack or shelf mounted.

No special devices are required to connect to the line. Standard 2000-volt signal lightning protection is believed to be satisfactory. No vacuum tubes are used, as the carrier equipment employs transistors.

Operation

Figure 3 is a schematic diagram of an Indiscan System showing a control office and two field locations, from which track occupancies are to be indicated.

The 75-rate code transmitter CT pole-changes direct-current energy from the battery on the two line wires LW1 and LW2. Connected to the line wires at the control office are carrier receivers, one for each corresponding transmitter in the field. The output of each receiver is alternately connected, by contacts of the code transmitter, to one of two indication relays associated with each receiver.

At the field locations, carrier transmitters are connected across the line. The energy supply for a transmitter is derived directly from the direct-current voltage on the line. The dual chokes L at the control office and at each field location permit d-c. energy to pass through but block the carrier voltage.

The operation at Field Location 1 is typical of all locations, with the exception of difference in carrier frequency.

The d-c. energy is taken from the line through a diode network so that when contact T1 of a track relay is closed and T2 is open, the transmitter receives energy only when LW1 is positive and LW2 is negative. The transmitter then develops a carrier voltage at frequency

F1 across the line which causes its associated receiver F1 to pick up indication relay K1, since this relay is connected to the receiver output when LW1 is positive. When the line polarity is reversed the transmitter output ceases (T2 contact is open), but K1 remains picked up due to the condenser C1 making it slow-release. If however, T2 is closed and T1 open, the transmitter will operate when LW1 is negative and LW2 positive, thus picking up K2, which is connected to the receiver output at this time. When both function relay contacts are closed, the transmitter operates with either line polarity and both indication relays pick up.

Thus for one position of the code transmitter a certain d-c. line polarity is established and the carrier receiver output is connected to a certain indication relay. If the function relay contact which allows the transmitter to operate with this polarity is closed, the carrier receiver will produce an output current sufficient to pick up the indication relay connected at the time. The other position of the code transmitter will reverse the line polarity, connect the other indication relay to the receiver output and thus bring in the remaining indication, providing the other function relay contact is closed.

The diodes in series with the indication relays are to prevent a run-around path through the common switching. Condenser C bridging the choke at a field location is to prevent line surges from damaging the diodes or the transmitter.

Capacity

Additional transmitters and receivers of different carrier frequencies may be added to the system to fit requirements, with two indications being provided for each carrier frequency. Any or all indications may be sent and received at the same time without interference.

Twenty-eight frequency channels can be provided, using carrier frequencies between 1 and 20 kilocycles. This provides facilities for 56 two-position indications. All indications will be received in a maximum time of 3/4 second. The indications may be displayed at more than one receiving location by the use of a polar line relay to switch the receiver outputs to the correct indication relays. These added receivers are simply bridged across the two line wires wherever the indication information is required.

Power

The system requires a battery, or power supply, of 12 volts at the control office. No local energy supply is required for the transmitters at the field locations, since transmitter energy is obtained directly from the line.

Transmitter power consumption is approximately 0.2 watt. Receiver power consumption is approximately 0.5 watt when receiving an indication, less than 0.03 watt when idle.

Other Applications of Transmitters and Receivers

Transmitters and receivers may be used to bring in indications over two line wires, without pole-changing the line or otherwise affecting it.

Each two-position function to be indicated requires a transmitter and a receiver, matched in frequency.

As shown in Figure 4, the transmitter may be located at a signal location, to indicate track occupancy. When the track relay contact closes, the transmitter develops a carrier voltage at a certain frequency across the line, which causes its associated receiver to pick up indication relay K.

Note that with this arrangement, unlike Indiscan, local battery, in this case the signal battery, is required at the remote location. The receiving location may be a control office, or a bungalow in a cTc installation. In the latter case, the indication received would then be transmitted to the control office by the regular cTc coding equipment.

By locating the transmitter at the control office and the receiver in the field the same transmitter - receiver arrangement may also be used for the control of a remote function, such as an outlying switch lock, or similar device.

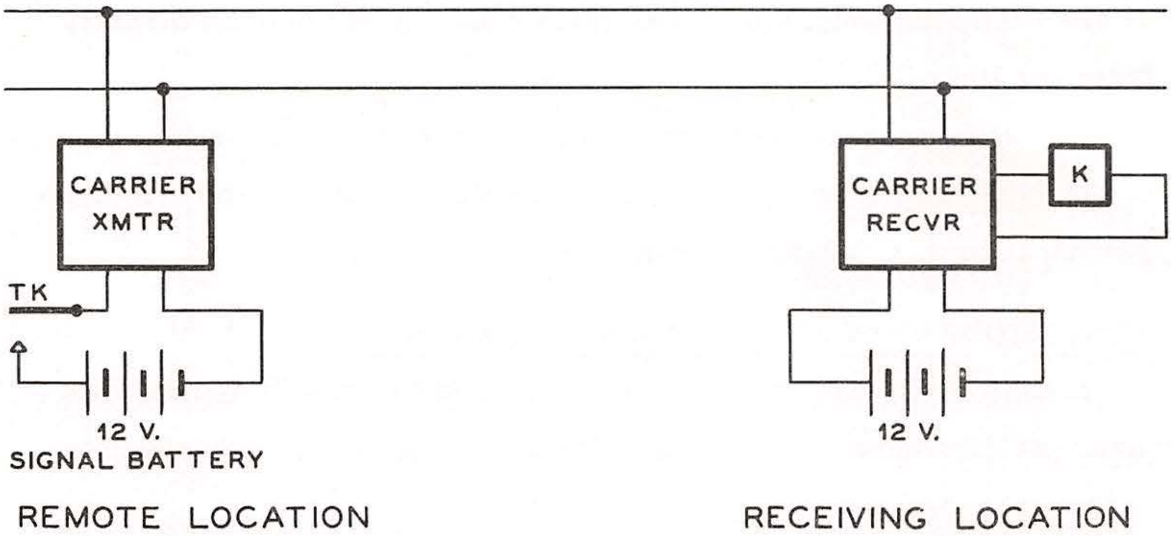

CARRIER XMTR
TK
12 V.
SIGNAL BATTERY
REMOTE LOCATION
CARRIER RECVR
K
12 V.
RECEIVING LOCATION

Figure 4. Diagram of arrangement for one indication.

OUTSIDE BUMPER PLATES ON DRAGGING EQUIPMENT DETECTOR

New outside bumper plates (blades) have been designed for use with our current model dragging equipment detector. These plates, Figure 1, are designed to detect dragging equipment which might shear off railhead bonds.

A sleeve is welded on the inside of the plate near the top. When the detector is installed in the field, a roll pin, four inches long,is driven into the sleeve with its slot in the down position. The roll pin is driven in until a spacing of approximately one-half inch (not less) is obtained between the railhead and the end of the roll pin. Thus dragging equipment which might otherwise slip between the railhead and the bumper plate now trips the dragging equipment detector when it hits the extended roll pin.

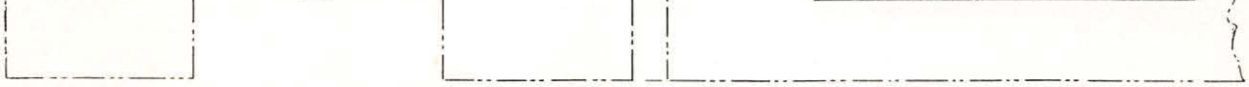


Figure 1. New outside bumper plates make dragging equipment detector more sensitive to dragging items near railhead.

COMPACT TERMINAL BLOCK

A new, compact terminal block, Figure 1, has been developed for relay racks, relay cabinets, control machines, and other signal equipment formerly requiring the use of standard A. A. R. terminals. The new block provides positive, low-resistance connections, ease of connecting wires, and substantial savings in space requirements.

As shown in Figure 2, three basic components are involved in the new arrangement: (1) an eight-prong terminal connector, (2) a solderless wire terminal, (3) a series of molded bakelite separators comprising the "honeycomb" terminal block.

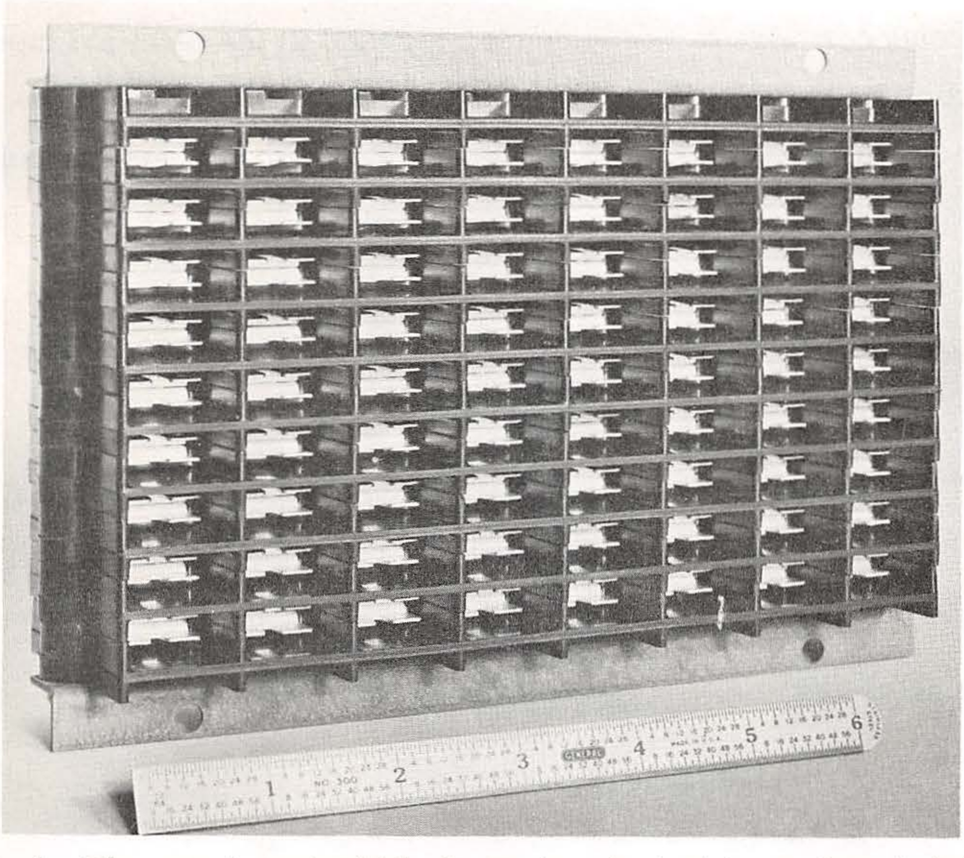


Figure 1. The new terminal block can be stacked to various heights.

Each terminal connector is a specially formed, silver-plated brass unit. A row of connectors is placed on a separator block in the spaces provided. Another separator block is placed on top, and more connectors are placed in position. The assembly operation is similarly continued until the desired terminal capacity is attained. A threaded stud is passed through the holes at each end of the stacked layers. A nut on the end of each stud holds the separators and the separate mounting brackets in place. Terminal block units containing 24, 56, 72 or 112 connectors are currently available.

The A-MP Faston wire terminals are silver-plated brass and are easily attached to the wires by means of a crimping tool. The conductor and its insulation are securely fastened to the terminal in the crimping operation. Terminals are available in two sizes: one to fit wire sizes 14 through 18, and one to fit wire sizes 18 through 22.

To connect a wire to the connector encased in the terminal block, the wire terminal with its attached wire is pushed onto one of the prongs of the connector. A lock tab on the terminal snaps into a lock depression on the connector. The design and material of the terminal

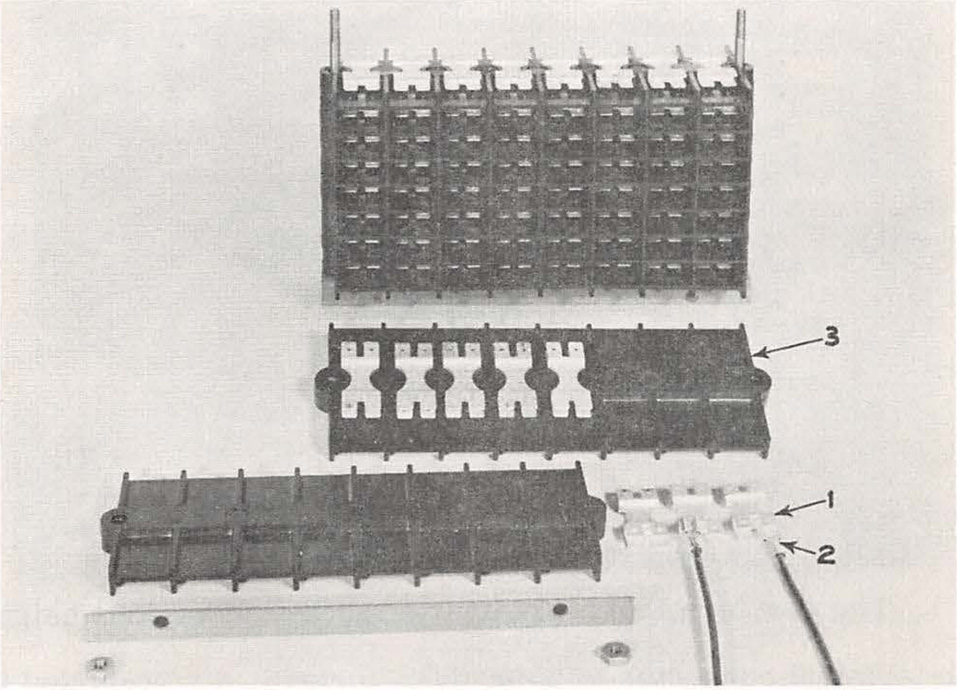


Figure 2. Components are: (1) eight-prong connectors (2) solderless crimp-on wire terminals (3) molded bakelite separators.

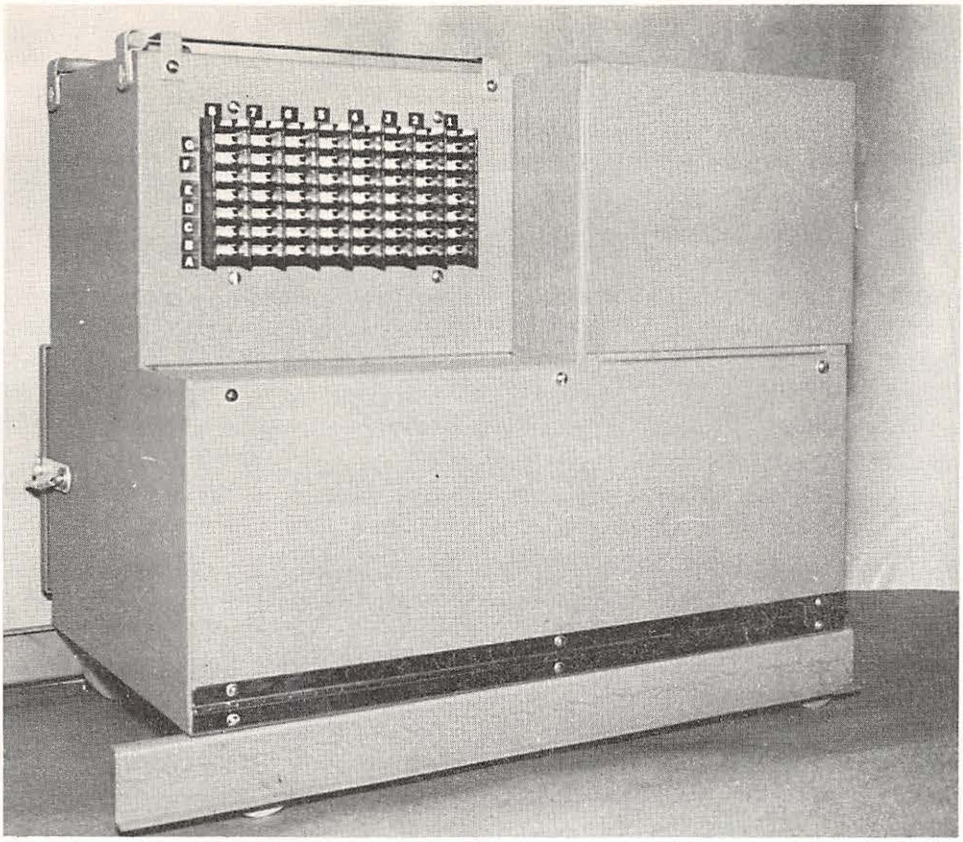


Figure 3. Here the new terminal block is shown as now used on Syncroscan control unit.

and connector ensure positive, low-resistance contact. A minimum force of from six to nine pounds is required to pull the terminal from its connector, thus ensuring against accidental removal.

By providing 1/4-inch creepage, the new type connections meet A. A. R. requirements for use in safety circuits. The cellular structure of the "honeycomb" eliminates the necessity for insulating sleeves on the ends of the wires.

The terminal block can be mounted to take advantage of its feed-through construction, such as shown in Figure 3, or it can be mounted flush with the wall for one-direction terminal wiring. Bussing of adjacent connectors can easily be done by jumpers.

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